31

E. & M. J.'s SMALL-MINE NUMBER

AUG 21 1940

ENGINEERING AND MINING JOURNAL

AUGUST, 1940

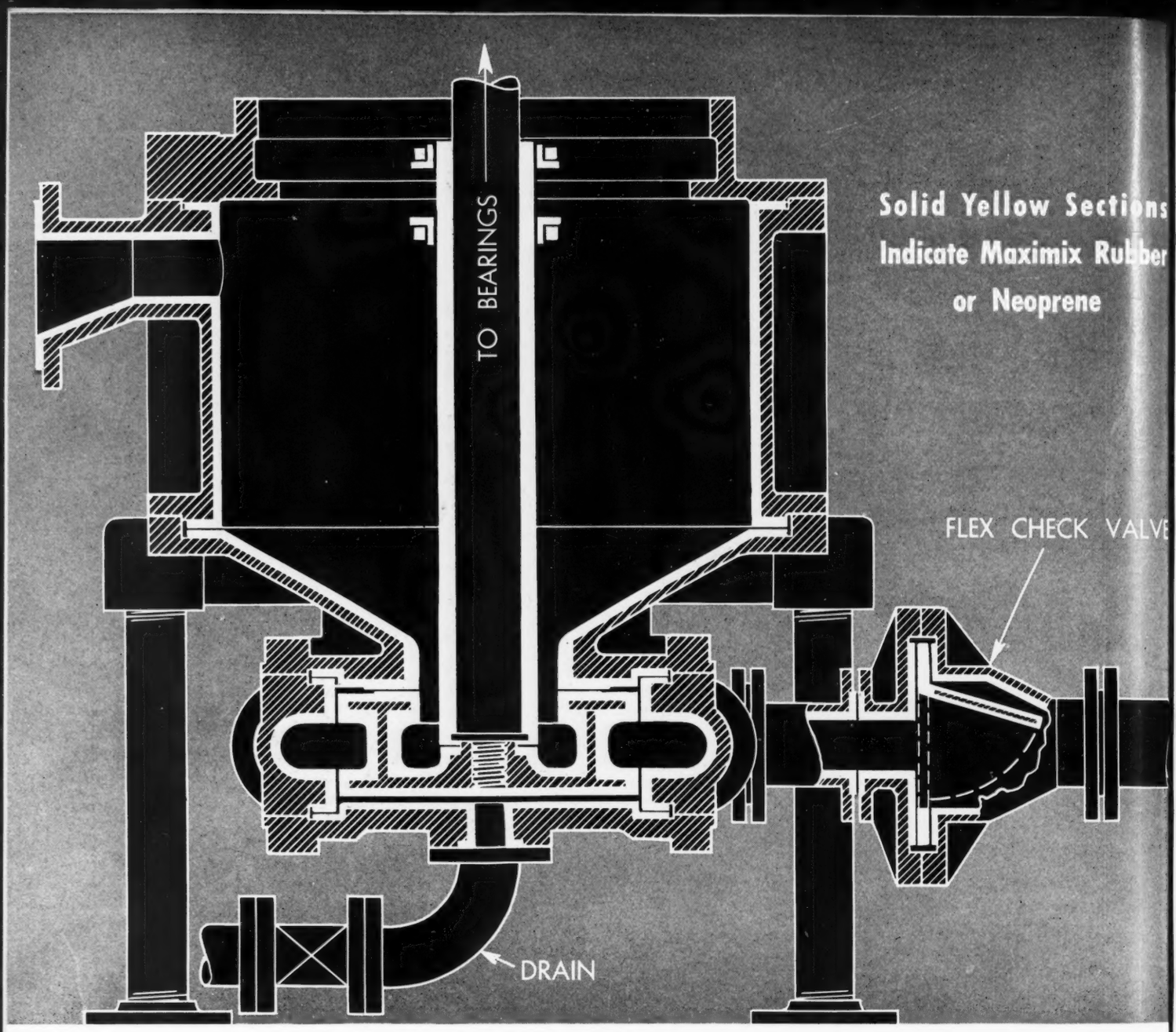
ome small-scale mining ventures. The Alhambra-humway 70-ton bonanza in California—Dragline dredging in Nevada—Hydraulicking in Alaska

In this issue

A score of articles on the operations and problems of the mining industry's many enterprises of small or modest size

MINING • MILLING • SMELTING

Complete contents on page 37



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Volume 141 AUGUST 1940 Number 8

IMPORTANCE OF SMALL MINES

LARGE AND SMALL, lode and placer, there are about 9,000 producing non-ferrous metal mines in the United States. But how many of them are so large and impressive as to be well known to the mining fraternity? Try to count them. Begin with Homestake, Utah Copper, Climax. Then add big companies like Anaconda, Phelps Dodge, New Jersey Zinc, Kennecott, Bunker Hill & Sullivan, American Zinc, St. Joseph Lead, and Howe Sound. And, finally, list the big smelting concerns that mine on their own account and treat small operators' ores on a custom basis—American Smelting, United States Smelting, and American Metal. Perhaps you can name a total of twenty.

All too soon, however, you run out of big names and suddenly realize that the great mining industry of the United States must be made up of thousands of small operations. That is true. Take Colorado, for example, the home of Climax Molybdenum, largest single tonnage producer in the State. In 1938 Climax mined more than 4,000,000 tons of ore, and shipped concentrates to the value of about $18,000,000. During the same period 669 lode mines and 592 placers reported production of nearly 2,000,000 tons of gold, silver, copper, lead, and zinc ores, valued at more than $22,000,000.

Obviously, small mines are important economic units. In the aggregate they account for the bulk of mining employment. They also contribute a substantial part of the total tonnage and value of ore mined. And as a combined market for equipment, materials, and supplies they take precedence over a handful of big producers. From the viewpoint of the custom smelter, they furnish the variety and quantity of ore that are necessary to maintain such operations.

So this issue of Engineering and Mining Journal is devoted to the small operation—mining, milling, smelting. The contents comprise two kinds of articles: first, those descriptive of the operating details and costs of typical small plants; second, those of a more general character dealing with the problems of management and operation of small mines, and layout and design of small cyanide and flotation mills. Both kinds of articles are invaluable to thousands of operators because they are written out of long practical experience. They speak the language of the fraternity.

The operating and management problems of a small mine or mill call for first-class talent. In fact, the small operation needs just as good management as the large one—possibly better, because it can survive fewer mistakes. Fortunately for the industry, our schools of mines have turned out such a liberal supply of professional talent that even the smallest operation need not be without at least one trained engineer. He is the key man at many a small mine or mill.

Operating the Small Mine

The peculiar problem turns on questions of management and supervision and differs in important respects from that of running a large property

Charles F. Jackson
Chief Engineer
Mining Division, U. S. Bureau of Mines
Washington, D. C.

INTELLIGENT APPROACH to the subject of operating small mines necessarily involves first a definition of a small mine. The one usually given is based on the rate of production. On this basis, however, the person making it is likely to be influenced by the scale of operations with which he has been connected. Thus the limiting daily output for a mine to be considered small has been placed by different engineers interrogated by me at 50 to 75 or 75 to 100 tons, up to 300 or 500 tons, or more. Doubtless a 1,000-ton mine would be thought small by those used to dealing with production from the large porphyry-copper and open-cut iron mines. The value of annual output, ore reserves, extent of mine workings, or depth of the mines likewise are unsatisfactory as bases for rating the size of a mine in this discussion.

I suggest that the distinction between a large and a small mine involves not only consideration of the rate of production and extent of the workings, but, more fundamentally, the complexity of the operations and the requirements as to management and supervisory staff. On this basis a small mine may be considered simply as the opposite of a large mine, which, for the purpose of this article, is one that requires delegation by the manager of responsibility for the various phases of operation to a number of subordinate supervisory officials. In this respect, the operation of small mines differs in important particulars from the operation of large mines. Lack of success in exploiting small mines often has been due in part to misunderstanding of this requirement.

Management and Staff—A manager is not infrequently employed for a small mine at a salary based on the size of the project, without regard to the actual requirements for technical and managerial skill. This policy is unsound and fails to consider that a competent man usually will save the additional salary he commands many times over. Successful management of a small mine requires broadly as high an order of ability as the management of a large mine, although the problems may be very different. Executive and organizing ability of a high order is essential for management of large mines, but though technical knowledge may be desirable, it is not always necessary, as technical and operating details are entrusted to capable subordinates. The capable small-mine manager must not only have executive ability but, especially in isolated districts, must be resourceful and versatile, and have technical knowledge or broad, practical operating experience in all phases of the work.

A small mine seldom will support a large staff unless the ore is exceptionally rich, and many small mines have failed because the organization was heavy at the top. Others, on a somewhat larger scale, have been unsuccessful because of unwillingness to pay a salary high enough to attract a competent supervisory official in a key position—for example, a mill superintendent where the ore is difficult to treat or a mine superintendent where the mining problem is troublesome.

In addition to key personnel in the mining and milling departments, modern practice requires the services of a competent master mechanic and electrician; at a small mine it may be desirable, and often is possible, to find a man capable of installing and caring for both the mechanical and electrical equipment. His salary may be much higher than that of a master mechanic or an electrician, but usually will be less than the combined salaries of both. Larger mines often find it necessary and profitable to employ an electrical superintendent and a mechanical superintendent, both of whom may be trained engineers.

At some small mines the services of a geologist may be required in addition to those of an engineer because of the complexity of the geology and the difficulty in finding new ore to maintain the reserve position. Under other conditions the mine engineer may be able to handle the necessary geological work as well as the mine surveying, mapping, mechanical design, and engineering computations. I recall one mine where I performed the duties of surveyor, assayer, sampler, draftsman, and geologist, and, for a while, acted as night foreman. Although this may have been carrying the combination of duties too far, it illustrates the point that most small mines, unless blessed with ore of very high grade, must operate with a minimum staff to keep the overhead within bounds.

Operating Personnel—One of the difficulties peculiar to the operation of small mines is due to lack of competent understudies for key jobs. The loss of a mine shift boss may be taken care of by promoting the timberman or a machine man, but there may be only one competent timberman, or the best miner may not have the qualifications for a good boss, so that this recourse may not be satisfactory. At a large mine there usually are a number of mechanics, one of whom can substitute satisfactorily for the master mechanic in emergencies, but the small mine will seldom have a second man competent to take over his duties for an extended period. The law may require that hoisting engineers have an operator's license, and the small mine usually cannot carry an extra licensed employee, simply to have a substitute at hand. Other situations will suggest themselves where the sudden loss of a key man presents a serious problem, especially if the mine is in a remote region. One must have had difficulties with respect to experienced personnel in a camp remote from a source of labor supply to realize that they amount to more than an annoyance.

Accounting—A system of cost accounting that will show clearly the unit costs for each of the operations involved is essential for efficient conduct of a small as well as of a large mine, yet the matter of adequate cost accounting often is neglected in the case of the former. Satisfactory accounts can be kept, however, without overstaffing the clerical department, if

(*Continued on page 44*)

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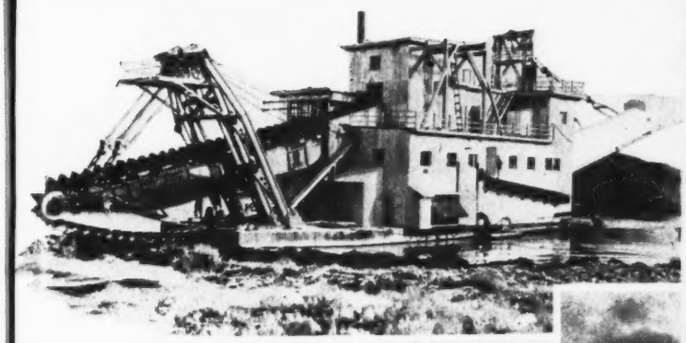

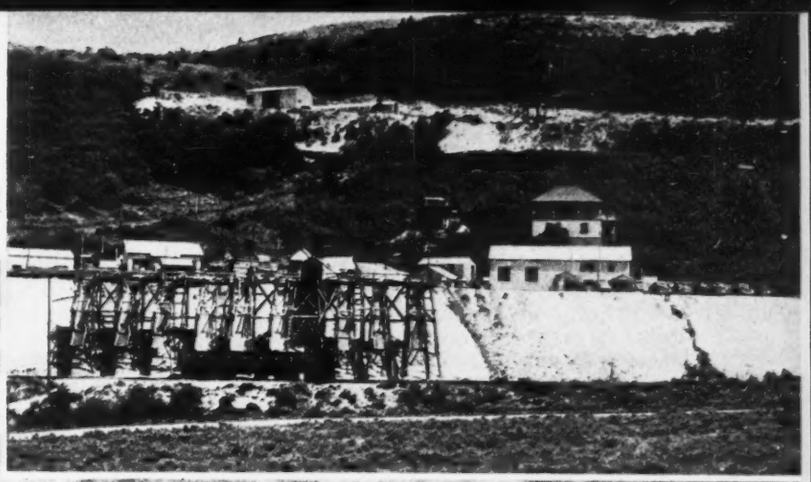

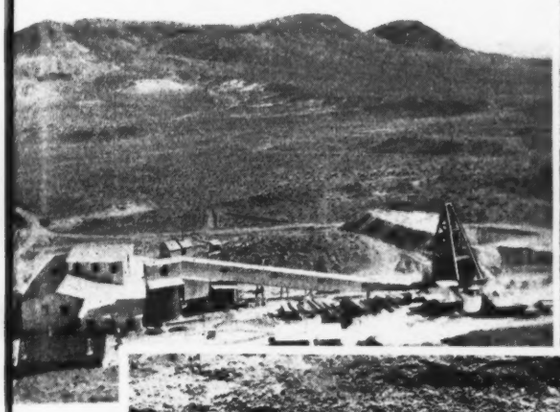

Some small mines in this issue

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non-essential clerical work is eliminated. Sometimes the home office demands monthly, bi-weekly, or even weekly reports that include items involving an excessive amount of computation for prorating distributive cost items. I have known of instances where such computations required the services of an extra clerk but after being made were meaningless because they were based on rough estimates and assumptions. Statements including such distributions should be required only once or twice a year, or at most quarterly, after the taking of inventories and accurate posting of other items involved in computing distributive costs. By properly systematizing the clerical work and eliminating unnecessary accounting, most small mines can carry accounts adequate for cost control with a staff of two men, one of whom can handle both warehouse and timekeeping if the time books are kept and turned in by the bosses.

Detailed discussion of cost accounting for small mines is beyond the scope of this article and moreover is treated elsewhere. Publications treating it include Bureau of Mines Bulletin 372[1] and McGrath's "Accounting and Cost Principles."[2] The form for summarizing costs adopted by the Bureau in its study of mining methods and costs has been employed, with slight modifications to suit local conditions, in routine cost accounting at several small mines without entailing an unusual amount of clerical work and has served satisfactorily for the purpose of cost control. A sample monthly cost sheet from one of these mines, but using approximate figures, is reproduced here in its tabular form. At mines that use a large quantity of mine timber it is advisable to show this cost in a separate column.

Exploration and Mine Development—Usually a small mine has ore blocked out for only a comparatively short time before stoping, and reserves are assured for only a year or two at most. If such a mine had large reserves of proved ore and capital for their development and for increased equipment, the scale of operations ordinarily would be expanded, and it would graduate from the small-mine class.

Most mines started as small ones, except the porphyry coppers and others having large low-grade deposits that must begin on a large scale to be profitable. Many small mines are not even potentially large ones, and others that might be, never are able to expand because of insufficient working capital. Some large mines that have developed from small beginnings were able to do so because the ore was of high grade at the start, and even with small production they could build up substantial cash reserves for aggressive exploration and development and expansion of the scale of work. With expansion in operations, unit overhead costs are lower and certain operating economies are possible, enabling the profitable mining of ores lower in grade than could be worked on a small scale. Thus the ore reserves may be enlarged further.

One of the greatest problems of the small-scale operator is, then, to maintain his ore-reserve position, which may be difficult owing to the nature of the ore occurrence, to the actual size of the deposits, or to lack of operating capital. The large mine often is in an even more difficult position with respect to maintenance of reserves, in the sense that the greater the tonnage mined each year, the larger the quantity that must be found and developed to sustain the scale of operations. Under conservative operating policy, however, the large mine usually will have funds available for the necessary development to maintain the ore-reserve position, or else, as the deposit becomes depleted, the decline in output and the end of large-scale operation can be seen some time before their actual occurrence, and operating policy can be determined accordingly. Also, in the operation of large mines, where there are many working faces, the grade of ore produced can be more or less stabilized. The small mine usually can maintain its output from a few stope faces, and unless enough spare faces are developed in advance, even temporary drastic lowering of the grade of ore from one or more active faces may lower the average grade from the mine below that which is profitable. If this situation is prolonged, the mine must be closed down.

Thus, a continuous program of well-planned exploration and development is essential for day-to-day operation as well as from the long-term viewpoint. The competent mine manager realizes this but not infrequently may be helpless because of short-sighted policy adopted by company officers, who perhaps have little familiarity with mining. A definite policy of spending a fixed amount per year or per ton of ore extracted, for exploration and development is essential for successful mine exploitation until it has been determined that no more ore is to be found or that the cost of finding and extracting it will exceed its value.

Maps and Engineering Records—Examining engineers often find it necessary to construct their own maps and sections when reporting on small mines, to get a clear picture of the ore occurrences and mine workings. To do this it is often necessary to piece together data recorded on a large

[1] Keller, Albert E.: "Accounting System and Office-Management Procedure for Medium-Size Metal Mines". Bull. 372, Bureau of Mines, 1934, pp. 84.

[2] McGrath, T. O.: "Accounting and Cost Principles". McGraw-Hill Book Co., 1921, pp. 260.

Blank Mining Company Operating Cost Statement. Month, 1940

Tons Milled, 6,000

	Supervision	Direct Labor	Compressed Air, Drills and Steel		Power		Explosives	Balls and Liners	Flotation Reagents	Other Supplies	Total Amount	Total Per Ton Milled
			Labor	Supplies	Labor	Supplies						
1. Development	.....	$900	$50	$150	$75	$150	$400	.....	.....	$175	$1,900	$0.317
2. Exploration (diamond drilling)	.....	500	.....	.....	50	100	.....	.....	.....	225	875	0.146
3. Mining	$750	5,000	350	1,000	500	1,000	2,000	.....	.....	450	11,050	1.841
4. Mine transportation												
(a) Hoisting	.....	800	.....	.....	100	200	.....	.....	.....	275	1,375	0.229
(b) Tramming	.....	1,375	.....	.....	.....	.....	.....	.....	.....	100	1,475	0.246
5. Pumping	.....	200	.....	.....	75	150	.....	.....	.....	.....	425	0.071
6. Milling	750	2,100	.....	.....	250	50	.....	$1,500	$150	450	5,250	0.875
(a) Water supply	.....	.....	.....	.....	150	50	.....	.....	.....	.....	200	0.033
7. Construction	50	250	.....	.....	.....	.....	.....	.....	.....	250	550	0.092
8. Engineering, sampling, assaying	.....	450	.....	.....	.....	.....	.....	.....	.....	150	600	0.100
9. General surface	100	650	.....	.....	.....	.....	.....	.....	.....	150	900	0.150
10. Mine office	400	.....	.....	.....	.....	.....	.....	.....	.....	20	420	0.070
11. Transportation of concentrate	.....	250	.....	.....	.....	.....	.....	.....	.....	170	720	0.070
12. Compensation insurance (est.)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	600	0.100
13. Home office (est.)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2,000	0.333
Totals	$2,050.00	$12,475.00	$400.00	$1,150.00	$1,200.00	$1,700.00	$2,400.00	$1,500.00	$150.00	$2,415.00	$28,040.00	.....
Per ton milled	$0.342	$2.079	$0.067	$0.192	$0.200	$0.283	$0.400	$0.250	$0.025	$0.402	$4.673	$4.673

number of maps and sketches of different sizes and shapes and drawn to different scales. The desirability of systematizing mapping and engineering records, even though the mine is small, is apparent; system will save time and effort.

Equipment—Noticeable improvement has been made in the equipment of small mines during the past decade, especially with respect to the relative number of such mines that have installed modern machinery. Many small mines remain that use second-hand and makeshift equipment, and often this is necessary because of lack of capital for purchasing modern equipment or because the probable remaining life of the mine does not justify it. Some mines visited by me in recent years seemed to have adopted certain types of equipment, particularly for milling, because such equipment was the vogue, rather than because their use had been determined after careful tests and engineering planning. Obviously, selection of the equipment for a small mine requires careful thought, taking into consideration capital available, present and probable future requirements, probable life, adaptability to conditions, and efficiency. Employment of a competent engineer in selection and purchase of equipment usually will save money in the end.

Most manufacturers of mine and mill equipment employ sales engineers or engineer salesmen who are specialists in their respective fields. Consultation with these engineers is helpful in the solution of equipment problems especially, at small mines financially unable to employ specialists in several lines. Although these men are naturally biased in favor of their equipment, and their business is primarily to make sales, those representing reliable concerns seldom will recommend equipment unsuited to the work. One good principle to follow is to leave experimentation with new machines, devices, and types of equipment to the larger mining companies that can afford to make tests, and to adhere to the purchase of equipment whose performance has been demonstrated by successful results in full-scale operation.

Mines in Remote Regions—Many small mines are in regions hard to reach, which introduces problems in the transportation of equipment and supplies in one direction and of the ore, concentrates, or bullion in the other. In addition, the remote mine often has peculiar personnel problems, some of which have been mentioned. Bunk-house and family accommodations must be provided, and last but not least of the management problems, in remote camps, is the boarding-house or "cookery" problem. It is trite to state that good workers cannot be retained if the "chuck" is poor. Furthermore, poor food or poorly prepared food is the most expensive in direct cost in the long run because of the increased amount that goes out the back door to the incinerator. To break even on a mine boarding house, good food and good cooking are essential. One head cook under whose ministrations I have been fed on several occasions adds that 30 regular boarders is about the minimum number that will not show a loss under the usual rates charged for board.

Cookery trouble caused by having different nationalities may be unusual, but has been experienced in one camp where about 30 of one nationality insisted on pork twice a day, whereas about an equal number of another nationality seldom would eat pork but required plenty of beef, mutton, and fish. One group could be beguiled into eating less meat (the most expensive camp food) by the art of an excellent and versatile pastry cook. Much more might be written on this subject, as anyone who has had a "boarding-house strike" on his hands in a remote camp will agree.

In camps cut off from supplies and provisions certain months of the year, as during "freeze-up" and "break-up" or during the entire winter, stocks must of course be accumulated. The rate of consumption of operating supplies is readily determined if accurate records have been kept; this applies to provisions as well, although experience may be required in stocking the latter.

Where conditions require workmen to remain in remote camps for long periods, they may become "stakey"; they have accumulated a "stake" because they have no place to spend their earnings, and so become careless about whether or not they hold their jobs, thus introducing another personnel problem. Some recreation facilities aside from poker and other games of chance are therefore recognized as essential under these conditions, and their cost will be more than repaid in the long run.

At isolated camps sanitation is of vital importance. Sanitary latrines, incinerators in which table refuse is burned after each meal (especially

Bureau of Mines Publications Dealing With Small Mines

FOOTNOTE 3

"Mining Methods and Costs at Porcupine United Gold Mines' Rochester Mines at Timmins, Ontario." Inf. Circ. 6470, 1931.

"Cost of Developing to Operating Stage and Equipping a Small or Medium-Sized Mine in Tri-State Lead and Zinc District." I. C. 6591, 1932.

"Federal Placer-Mining Laws and Regulations—Small-Scale Placer-Mining Methods." Tech. Paper 591, 1938.

"Mining Methods and Costs at Vanadium Mine of United States Vanadium Corp., Rifle, Colo." I. C. 6662, 1932.

"Methods and Costs of Mining Ferberite Ore at Cold Springs Mine, Nederland, Boulder County, Colo." I. C. 6673, 1932.

"Method and Cost of Exploring, Equipping for Development and Developing Central Patricia Group of Claims, Northern Ontario." I. C. 6681, 1933.

"Notes on Methods and Costs of Equipping and Developing Prospects." I. C. 6693, 1933.

"Methods and Costs of Developing and Equipping Ashley Gold Mine, Matachewan Gold District, Ontario." I. C. 6707, 1933.

"Mining Methods and Costs at Granada Gold Mines, Ltd., Rouyn, Quebec." I. C. 6709, 1933.

"Cost of Equipping and Developing a Small Gold Mine in Bradshaw Mountains Quadrangle, Yavapai County, Ariz." I. C. 3735, 1933.

"Essentials for Preliminary Report on Small Lode-Gold Mine or Prospect." I. C. 6748, 1933.

"Prospecting for Lode Gold and Locating Claims on Public Domain." I. C. 6843 (revised): 1935.

"Costs of Trucking and Packing Ore in Western Gold Mining Districts." I. C. 6898, 1936.

"Mining and Milling Methods and Costs, Hog Mountain Gold Mining & Milling Co., Alexander City, Ala." I. C. 6914, 1936.

"Open Schedules for Gold and Silver Ores and Concentrates at Western Custom Smelters." I. C. 6926, 1936.

"Design of Small Wooden Headframes." I. C. 6943, 1937.

"Mining and Milling Methods at Pilgrim Mine, Chloride, Ariz." I. C. 6945, 1937.

"Mining and Milling Methods and Costs at Golden Messenger Mine of United Gold Mines Corporation, York, Mont." I. C. 6947, 1937.

"Mining Methods and Costs of Quartz Hill Mining Co., Dewey, Mont." I. C. 6963, 1937.

"Milling Methods and Costs at Mill of Tom Reed Gold Mines Co., Oatman, Ariz." I. C. 6975, 1937.

"Operations and Costs at St. Joe Mining & Milling Co., Boulder, Colo." I. C. 6976, 1937.

"Gold Mining and Milling Methods and Costs at Gold Hill Mine of Talache Mines, Inc., Quartzburg, Idaho." I. C. 6985, 1938.

"Mining and Milling Methods and Costs of Golden Anchor Mining Co., Burgdorf, Idaho." I. C. 7024, 1938.

"Mining and Milling Methods and Costs at Summitville Consolidated Mines, Summitville, Colo." I. C. 6990, 1938.

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in warm weather), screened meat houses, and a supply of pure drinking water or boiling or treatment of all drinking water are essential.

In remote camps it may be necessary to engage a resident physician, even though operations are small and only a few men are employed. The physician, who does not have much to do in a small camp (the less, the better), is the logical staff member to supervise and maintain the sanitary system. I recall one remote camp, where, although only about 125 men were employed, it was necessary to have a resident physician, a radio station and radio operator, and a contract for regular service with a commercial airplane concern. Such services entail high overhead unit cost where output is small, but sometimes they are unavoidable.

The Bureau and Small Operators—Several years ago it was felt that the Bureau of Mines should give more attention to the problems of small mines. Accordingly, field studies were made of a number of such mines in the United States and Canada, and several publications were issued thereon.[3] Investigations were made both at selected individual small mines as an extension of the study of mining and milling methods and costs at larger mines and as part of the mineral industries survey by districts or counties. The latter resulted in a series of publications[4] in which the individual general geological setting of the ore occurrences and the mining and milling operations are described, operating costs are reported, actual smelter returns are given on shipments of typical ores and concentrates from each district, and freight, trucking, and power rates are shown. These call attention to individual properties and provide economic information essential to examining engineers.

While engaged in this work, Bureau engineers are available for technical advice to prospectors and small-scale operators, who obviously are financially unable to employ competent technicians. When advice is requested by companies able to pay for technical service the employment of competent consultants or a regular staff engineer is suggested. Published geological maps are interpreted if desired, simple fault problems are worked out, and suggestions are made regarding the best methods for prospecting, development, and mining and as to the most suitable type of equipment to install. Limited appropriations and personnel have permitted only a limited service of this kind, but wherever it has been possible to give it, it has been popular and appreciated, and has resulted in more efficient expenditure of effort and money.

[3] See bibliography on page 45.

[4] See bibliography on page 45.

A distant view of the mill and surface plant of Surcease Mine, at Yankee Hill, Calif.

Policy of Surcease Mine a Conservative One

This small California gold producer seeks to minimize its capital risk and has continuous operation as an objective. Milling 75 tons of ore per day

Allan E. Jones
General Manager
Surcease Mine, Yankee Hill, Calif.

TWENTY MILES northeast of Oroville, Calif., in the Big Bend district of the Feather River, is the Surcease mine. It represents a localized area of mineralization near the known northern end of the California gold belt. A short distance east of the Surcease workings is a small area of granite. The known veins of the Surcease area occur in massive amphibolite and amphibolite schist surrounding this granite, and to a somewhat lesser extent within it.

Two distinct vein systems exist. The most important, that of the majority of the veins, strikes N. 30 deg. W. at the southern end but gradually swings N. 10 deg. E. at northern end, dip averaging 30 deg. E. The two producing veins belong to it. Exploration is in progress on two others. Quartz is fairly continuous, though often splitting to form lenses on either wall if the fissure zone is wide. Widths of quartz vary from 1 to 10 ft., with

ore occurring on any width. The ore is found in irregular bodies often having greater length on the strike than on the dip. The flatter dips appear the most favorable. The Surcease vein dips 20 to 40 deg. E.

The second system strikes north and south, and dips 70 deg. east. These veins are in the granite or on the contact with the amphibolite. Scattered lenses of ore, from 1 to 2 ft. wide, were found in two exploration adits. An attempt at mining them was unsuccessful, but it is of interest that quartz containing fair values was found in open cuts extending 2,000 ft. Near the center of the area is a fault zone that strikes N. 70 deg. E. and dips 70 deg. N. The structure cuts all the important veins but displaces them very little. Most of the ore has been found on either side of this structure and within 500 ft. of it.

The property was first opened in 1915, with a shaft being sunk on the Surcease vein to the 600-ft. level. Drifts were run on the 165, 210, 300, and 600 levels. In this early development it is said that some 25,000 tons of 0.4-oz. ore was blocked out in the upper levels, but the ore apparently bottomed on the 300 level. At that time the ore showing was not thought sufficient to justify a mill. In 1925, leasers built a 40-ton mill and cyanide plant, and worked out the proved ore in the upper levels. Several later attempts to reopen the mine met with little success. The property was acquired by its present owners, Hoefling Brothers, 1812 D. St., Sacramento, Calif., early in 1933. With no preconceived ideas as to the size of operation wanted, or the time required to show a return, the following policies were decided upon:

1. Capital risk would be kept as low as possible even at some loss of possible return.
2. Any earnings would be available for further development of the property.
3. Additional capital would be provided only when needed.
4. Continuous operation and steady growth would be preferable.

Low capital risk during the exploration and development phase has been accomplished by making full use of mill equipment on hand at the start, gradually adding to it with the least possible cost at some sacrifice of mechanical and metallurgical efficiency, while the emphasis was put on the search for ore. It has taken time, but with an average yield of 10 tons of ore per foot of development done, exclusive of raises run in ore, a prohibitive capital investment in development would have been necessary if conventional procedure of full mine development before milling had been followed.

The increase in the price of gold made some tonnage of marginal ore available in the old workings. The mill was started at a small capacity, and a short-range development program in and around the old workings was begun. This was successful in finding an extension of the ore north of the main fault. Later the program was extended to include prospecting of the surface of the whole area, and four exploration adits were run on the prospects uncovered.

In the latter part of 1938 the mine began to show promise when new orebodies of better grade were opened on the 600 and 775 levels of the Surcease vein. The No. 4 vein began producing early in the same year.

Table I shows recovery, costs, and expenditures for improvements and equipment.

Table I—Gold Recovered, Cost, and Capital Expenditure

Year	Tons Milled	Value Recovered Per Ton	Total Cost (*a*) Per Ton	Capital Expenditure Per Ton (*b*)
1933	2,283	$5.88	$5.10	$0.44
1934	7,843	7.50	6.64	0.74
1935	9,344	6.53	7.34	0.85
1936	15,319	9.82	7.69	1.25
1937	18,278	9.33	9.25	0.52
1938	23,987	7.65	7.04	0.49
1939	22,170	11.70	8.95	0.48

(*a*) Includes all operating, development, realization and administration costs.

(*b*) Includes all capital investment for the year. Does not include amortization of the original cost of the property.

The workings on the Surcease vein are served with an underground hoist at the 210 adit level of the old shaft, which has recently been put down to the 950 level. Above the 210 level, the shaft is caved. Below this level it consists of a 5x5-ft. haulageway and a 5x3½-ft. manway. A 1½-ton skip is used.

Stoping is in progress on the 600 and 775 levels. Average width mined is about 4 ft. Raises are put up on strong showings of ore, with an attempt made to center these if possible. They are carried as wide as hanging-wall conditions will permit, usually 8 to 12 ft. Mucking is done with double-drum air hoists scraping directly into cars. Raises are run to the next level, or to the definite limits of the ore. Stoping is done by fanning out 50 ft. on either side at the top of the raise and retreating down. Stulls and headboards are usually the only support necessary. If the ground becomes heavy, the last line of stulls next to the ore is lagged off and the open section allowed to settle down. Any low-grade spots are left for pillars. If the ore limits are reached on either side of the stope, the next raise is run at a greater interval. The ore lenses are irregular in size and outline, but are usually connected. The connecting links are watched for as the stope comes down, and a sublevel off the stope is run in on them, using the scraper from the main stope to haul the muck across. If there proves to be only a small orebody, the ore is taken out through the stope. Hand tramming is used.

Development on the Surcease vein is done by sinking the main shaft and driving levels on the fissure, the interval being 175 ft. Raise pockets are cut in the hanging wall of the shaft. These are usually untimbered except for a row of center stulls to carry the divider for ore and waste pockets. Pocket capacities range from 60 to 100 tons, with the ore section about 50 per cent larger than the waste section. The main hoist served for sinking to the 950 level, below which it is planned to use an auxiliary hoist, installed at the 950 level, to release the main hoist for general mine use.

It is characteristic of the mine that the quartz will usually run above 0.20 oz. or below 0.06 oz. The values do not grade out; they end abruptly. However, within the lens they are fairly consistent. At times, where the fissure is wide, they may change from one lens to another, either overlying or underlying the one being mined. A small diamond drill, of the prospector type, has proved of real worth in checking these splits.

No. 4 vein is opened by an adit 200 ft. on the dip below the outcrop. Ore is hauled to the mill by truck. The vein averages about 2 ft. in width with 1 to 2 ft. of crushed and folded barren schist between it and the hanging wall. It parallels the Surcease, about 900 ft. from it in the latter's hanging wall.

Stoping is started at the top of the raise in a manner like that used in mining the Surcease vein. However, close timbering is required. Five-foot cuts are started on both sides of the raise at a slight angle. The face is drilled out, and the fill blasted first. This is gobbed in the previous cut. The ore is then shot as lightly as possible to prevent scattering and is scraped directly into the car by using a roller spiked to the post where the cut takes off from the raise. On the low side of the cut 2x12-in. planks are nailed to the posts to guide the scraper. Rollers and planks are moved down one set when a new cut is started. No ore pillars are left.

For developing the lower section of the No. 4 vein a two-compartment winze, each compartment 5x5 ft. in the clear, has been sunk one level. The level interval is 125 ft. Sinking on this job was done with a small air hoist and a half-ton skip. Recently, this winze has been driven through to the surface, and a surface installation with electric-driven hoist is planned.

Throughout the mine every effort is made to hold down dilution in stoping to allow as much low-grade ore as possible from development to pass to

the mill. When possible, in development work ore and waste are blasted separately. Daily car samples are taken from all stopes, and close cost control is kept. Marginal sections have been avoided in anticipation of there being more favorable conditions when mill capacity and recovery are increased.

When operations began, milling equipment consisted of an 8x15-in. crusher, two 4x3-ft. ball mills (one with a broken journal), a 27-in. classifier, two concentrating tables, four 10-ton leaching tanks, a 14-in. rake classifier, a 13-ft. thickener, two 12x10-ft. agitators, and two zinc boxes. Grinding was done in cyanide solution. In 1933 and part of 1934, milling was somewhat intermittent until operation was put on a 24-hour basis, in the middle of 1934. Recovery of the precious metal at this time was maintained at about 85 per cent.

During 1935, a 20-mesh trommel screen was added to the ball mill, increasing tonnage and producing a better table feed with no appreciable rise in the final residues. Late in the year and early in 1936, four 50-ton leaching tanks and two more 12x10-ft. agitators were installed, increasing the cyanide contact time. Tonnage was maintained at about 50 per day for the following year. During that period of steady production the second 4x3-ft. ball mill was repaired and used as a standby. When conditions in the cyanide plant warranted, both mills were operated in parallel until the 13-ft. thickener would become overloaded. One mill was then stopped until the thickener was cleared, and the procedure repeated. In this manner some precious extra tonnage was produced without capital expenditure or noticeable tailing rise.

Thickener capacity was keeping mill capacity down, and new ore developed in the No. 4 vein promised thickening difficulties owing to considerable oxidation. With these factors in mind, a new 26-ft. thickener was installed late in 1937, along with an additional zinc box and a 27-in. sand-slime classifier. Average tonnage milled was about 65 tons per day during 1938. With a screen-sized product from grinding, about 75 per cent of the total ore was leached in cyanide solution and about 25 per cent subjected to batch agitation. A recovery of 86 to 88 per cent was maintained. Most of the gold losses occurred in freed sulphide, too fine for tabling but also too coarse to respond readily to cyanidation. For this reason flotation was considered.

Early in 1939 four 44-in. sloping-side Fagergren flotation cells were installed, with the natural change to milling in fresh water. At the outset of this change the tonnage of oxidized ores in sight was considered negligible, and it was estimated it would be mined in 60 days. From test work already done a low-grade slime residue could be expected on sulphide ores. Cyanidation of the slimes was therefore thought economically unnecessary. Immediately after the plant was again in operation additional oxidized ore was found, and the slime-treating plant was hurriedly pressed into service. This time, however, the plant was assembled as a counter-current washing plant, utilizing three 12x10-ft. thickeners and two 12x10-ft. agitators. Incidentally, since then 15,000 tons of oxidized ore has been milled. Screen sizing allowed large particles of sulphide from table middlings to enter the flotation machines, and eventually a 39-in. duplex classifier was installed in closed circuit with both mills. Results for 1939 were encouraging, with a steady increase in recovery obtained from experience gained in treating the widely different ores. Recovery of 89.9 per cent for the year was shown after making a poor start. Another variable met in flotation was water shortage, which necessitated returning the mill water many times.

During the first five months of 1940 improvements have been made in both costs and recovery, with an average recovery of 92.5 per cent (90 per cent lowest and 94.4 per cent highest). Grinding for this period has been 2 to 4 per cent on 20 mesh, with an average daily tonnage milled of 73.4. This relatively coarse grinding has been resorted to in order to keep the tonnage up in the two small grinding units.

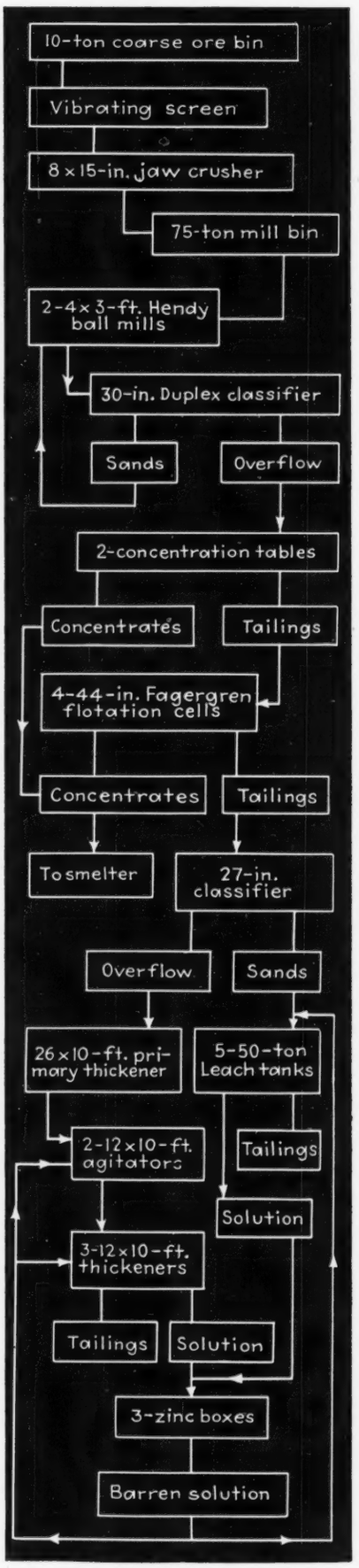
In the same period, during which 11,002 tons with an average head value of 0.314 oz. per ton was milled, the mill costs given in Table II on the opposite page were made.

Extensive experiment has been done on the Surcease ores by the American Cyanamid Company, Pan-American Engineering Company, and at the mine, with a view to increasing the milling capacity, and at the same time using much of the available equipment. Some generalities deducted from these investigations may be stated as follows:

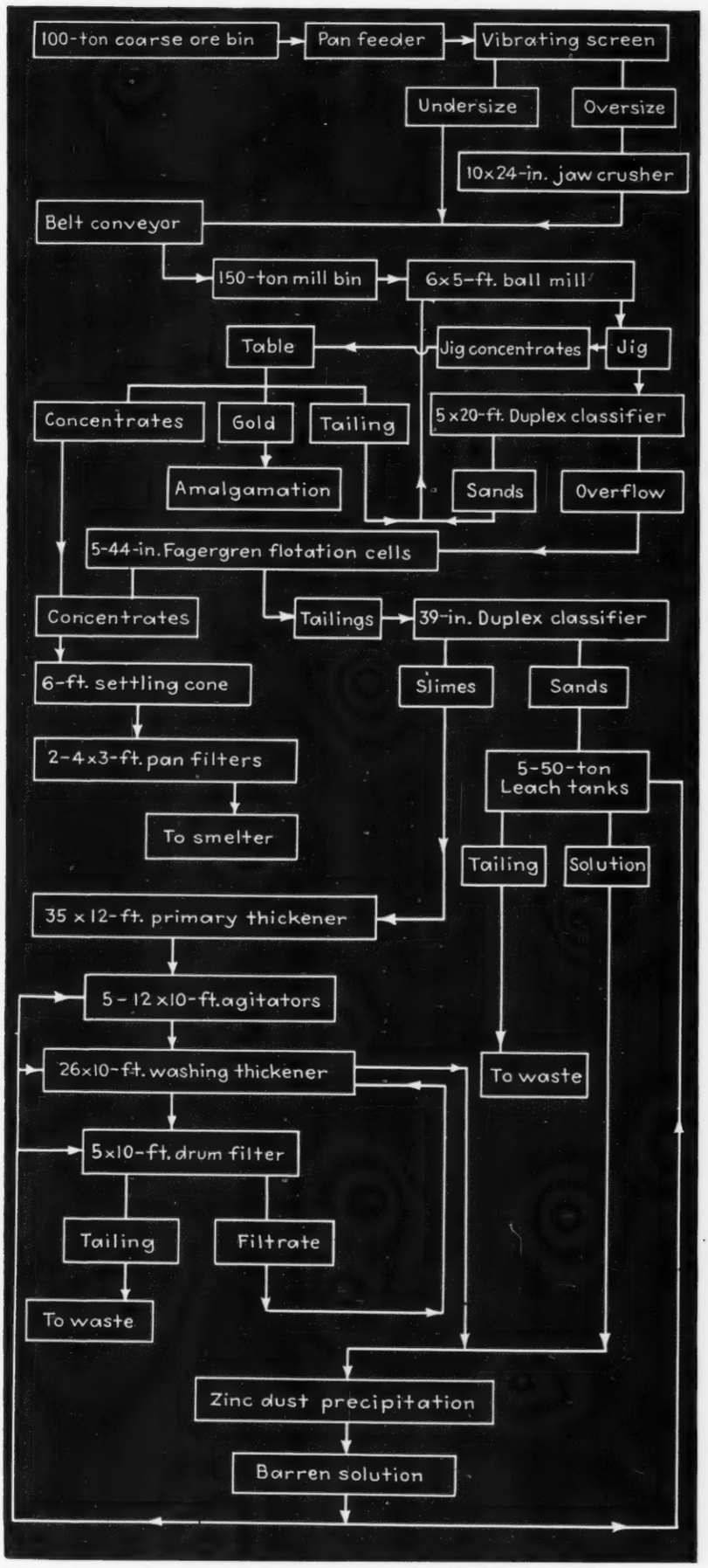
Minerals identified in sulphide ores of the Surcease vein from microscopical examinations are pyrite, chalcopyrite, marcasite, free gold, and galena. Minerals identified from oxidized ores in the No. 4 vein by similar examinations are limonite, pyrite, galena, chalcopyrite, covellite, bornite, pyrrohotite, native antimony, bournonite, and gold.

Optimum recoveries on both oxide and sulphide ores in flotation followed by cyanidation are effected by grinding between 35 and 48 mesh.

Optimum recovery on sulphide ores by flotation alone is found to be at all minus 65-mesh grinding. A reagent combination of sodium carbonate,



The present flowsheet of the Surcease mill. Extensive experimentation has been done to increase the capacity



The flowsheet that is proposed for the Surcease mill

Minerec "B," Pentasol xanthate, and lead acetate in grinding, and Pentasol xanthate, Reagent 404, and Aerofloat No. 15 in roughing, yields a 0.011-oz. tailing from a 0.272-oz. head. Cyanidation of this flotation tailing shows a 0.001-oz. residue possible. This tends to show that even with excellent flotation results, it is probable that cyanidation of the flotation tailing would yield a profit.

Oxidized ores are in two distinct groups. One group is quite refractory to both flotation and cyanidation, whereas the other is more amenable to both phases of treatment. A considerable amount of metallurgical testing has been extended to the more refractory ores, inasmuch as they represent a sizable proportion of the present ore reserves. A typical result from these examinations shows: Heads, $17.22; flotation tails, $8.47; slime cyanidation tails, $1.82; sand cyanidation tails, $1.26; and final residue, $1.57.

Microscopical examinations conducted by the American Cyanamid ore-dressing laboratory on oxidized minerals showed that gold occurred chiefly as fine particles inclosed in limonite. The largest particle of gold examined was 20 microns in minimum diameter, but most of the gold particles measured less than 5 microns in minimum diameter on this examination.

The less refractory oxidized ores present a much simpler problem. Test work shows that a 16 to 40c. residue can be expected from a head value between $8.50 and $9.50 per ton, with flotation treatment followed by cyanidation and grinding all material to minus 35 mesh.

Plans are under consideration to increase mill capacity to 100 to 120 tons per day. Water shortage has been eliminated by installing a 4-in. pipe line 12,000 ft. long. New coarse-and fine-ore bins are contemplated as well as a new ball mill, classifier, and jig. Present washing thickeners are to be converted into agitators, and one large washing thickener and filter will be installed.

The mine staff includes W. E. Messner, mill superintendent; Kevin Malone, mine superintendent; Milo Horner, master mechanic; and Jack Warren, accountant.

Table II—Milling Costs

	Cost Per Ton Milled
Total labor	0.423
Balls and liners	0.174
Power	0.224
Cyanide, lime, and zinc	0.151
Flotation reagents	0.071
Miscellaneous supplies	0.072
Assaying	0.076
Tailing disposal	0.046
Superintendance	0.091
Marketing charges	0.611
Average tailing	0.830
Total milling costs plus tailing loss	2.77

Summit King's mine and mill, near Fallon, Nevada, on the Lincoln Highway

Summit King Mills 70 Tons of Silver-Gold Ore Daily

With a small force this subsidiary of Bralorne Mines is working the deposit found two years ago in Nevada, with notable results. Property is on Lincoln Highway

Percy G. Dobson

Manager, Summit King Mines, Ltd.
Fallon, Nev.

TWO YEARS AGO, in November, Bralorne Mines, Ltd., of Vancouver, took an option on the Dan Tucker group of claims 30 miles southeast of Fallon, Nev., on the Lincoln Highway. Eight months later, when sufficient ore had been indicated to justify an operating company, Summit King Mines, Ltd., a wholly owned subsidiary, was formed.

Of interest is the circumstance that the vein outcrops prominently less than 600 ft. from the main highway, and that three years ago the property was allowed to pass into the hands of four employees to satisfy a labor lien of a few hundred dollars. These men, in trying to gather up a little shipping ore, opened a tiny streak of high-grade gold-silver ore, which, although thought to be only a small pocket at the time, developed into a large continuous orebody.

This ground was first staked in 1912 by L. L. Leonard, who named the property the Dan Tucker group. Since then several companies prospected the ground but found nothing encouraging. When taken over by Bralorne a few cars of ore had been shipped and development consisted of several open cuts and shallow tunnels and three shafts not exceeding 150 ft. in depth.

The Dan Tucker shaft followed a strong vein dipping 40 deg. to a depth of 125 ft. In drifts on both sides of the shaft on the 80-ft. level a small amount of milling ore had been found, but on the 125-ft. level the vein was below commercial grade. It was some distance east of the shaft that the high-grade streak mentioned was cut. It proved to be a narrow footwall branch of the main vein.

To prospect this possibility Bralorne Mines at the outset decided to steepen the shaft, starting at the 80-ft. level, and to take off into the footwall of the lean vein that had been followed by the shaft to the lower level. Success has been phenomenal. In the first round a 10-in. band of very high-grade ore was cut and on the 200-ft. level, 100 ft. below, it had opened to 5 ft. width. On the 200 and 300 levels a continuous orebody 800 ft. long and 2 to 10 ft. wide was developed. In twelve months' time 4,000 ft. of work had been accomplished and two years' ore supply for a 70-ton plant had been completed, and production was begun.

Ira B. Joralemon, consulting geologist for Bralorne, is president of Summit King, and directed the development and equipment. The mill was designed by Fred E. Gray, manager of Desert Silver, Inc., of Silver Peak, Nev., and was built by Southwestern Engineering Company, of Los Angeles.

As the mine is on a paved highway only 35 minutes drive from Fallon, all employees live in town and there are neither residences nor a boarding house at the mine. The office is in Fallon.

This section of Nevada is characterized by a series of north-south mountain ranges separated by arid valleys and occasional alkali flats. Important rock types are Tertiary volcanics and intrusives which appear to rest on a basement of pre-Tertiary (Mesozoic?) limestones and schists which have been intruded by granite. In the vicinity of the mine the (Mesozoic?) sedimentaries have been intruded by a large body of Tertiary andesite having an east-west trend. Intruding the andesite are occasional small rhyolite and basalt dikes and overlying the andesite are remnants of a basalt flow older than the veins.

One hundred to 400 ft. within the andesite and paralleling the sedimentary contract is a strong system of branching and nearly parallel veins extending 10,000 to 12,000 ft. in an east-west direction and dipping 30 to 65 deg. to the south, toward the contact. For much of this distance the outcrops consist of prominent exposures of nearly barren silicified ledge matter or white lamellar quartz, pseudomorphic after calcite. Only occasionally, in softer vein material, generally in the footwall of the prominent outcrops, were encouraging values found. In the mine good values are found to underly sections where no outcrops can be seen.

These ore deposits are of the low-temperature, shallow-depth or epithermal type, and are similar to those found in the Tertiary bonanza camps of Nevada. The silver-gold ratio of the ore is 79 to 1, but in parts of the mine it varies from 100 to 1 to 28 to 1.

Except for small areas where the vein has been squeezed out by strike-faulting, the entire length of 800 ft. developed to date, on and above the 300 level, is good ore. On the 400 level much of the vein developed thus far has been lean, but a body of high-grade sulphide ore has recently been found.

The vein material, on and above the 300 level, is highly oxidized, stained slightly by iron, and consists of soft shattered quartz and small amounts of kaolin probably derived from the alteration of adularia and occasionally calcite. Above the level the gold and silver occurs mainly as free gold, electrum, cerargyrite, and possibly argentite, but on the 400 level the silver appears to occur to a much larger extent as sulphide.

Two types of quartz, calcite and apparently barren veins, indicate at least three periods in which vein material was deposited. Calcite and dull, hard, bony quartz are characteristic of very low-grade or barren areas. Propylitic alteration of the wall rock is common. Present indications are that the zone of primary ore deposition is limited between a definite floor and ceiling in a comparatively short vertical range. Supergene enrichment of gold and silver has not been recognized as of great importance in localization of values, except possibly on the bottom level.

Normal faulting is prevalent and has

resulted in vein displacements ranging from 10 to 160 ft. There appear to be at least three systems of faults, the most important of which strike N. 25-42 deg. W. and dip approximately 70 deg. southwest. A second series strikes about N. 12 deg. E. and dips 60 deg. southeast. The third series consists of strike faults within, or on, the footwall of the veins, the strike varying from N. 70 deg. W. to N. 70 deg. E. and the dip from 35 to 60 deg. to the south.

The mine is developed by an inclined shaft, dipping 35 to 50 deg. to the south, which follows the vein to a depth of 465 ft. From it there are four levels at approximately 100 ft. intervals. Five pockets, one for each level and one just below the surface, are provided. Into the surface pocket is scraped dump ore, or ore produced from surface prospecting can be trucked to it.

The shaft is equipped with a 0.8-ton skip with which it is possible to hoist 80 to 100 tons per shift.

As the vein is a little too flat for shrinkage stoping, open stopes supported by stulls are raised from level to level. In starting a stope two or three rounds are blasted onto the level. A light chute is then installed and, as the stope is extended, a row of stulls on each side of the chute is carried up the vein at about 45 deg. from the floor of the level and lagged over, forming wings which divert the ore into the chutes. Chutes are placed at 25-ft. intervals. The levels are not timbered.

The ore mined varies from 1 to 10 ft. in width, averaging about 4 ft. Faults, rolls, and horses make the stope walls exceedingly irregular and careful mining is necessary to avoid undue dilution and to be certain no ore is left in the walls.

Rather than take a larger tonnage and allow a certain amount of dilution it has been found more economical to mine the ore carefully with as little dilution as possible. Even in these flat veins, stopes 2 ft. wide can be carried and often the grade is so high that it pays to mine the vein where it is 1 ft. wide. In this case the ore is taken out first and then about a foot of the footwall or hanging wall is mined and left as filling.

Careful sorting is found to be advantageous and feasible, inasmuch as the vein material breaks in fine particles, whereas the wall rock breaks as larger fragments of andesite. Waste is removed as the cars are loaded at the chute and again on a grizzly where the ore dumps from the skip into the ore bin.

As the ground is soft, light drills were thought most suitable. For drifting, JA 55 mounted Ingersoll-Rand Jackhamers are used. In the stopes and raises Sullivan S-20 automatic stopers proved satisfactory. These stopers, which weigh only 82 lb., are equipped with a special valve for soft ravelley ground, and a jackhammer front head and steel holder. Shanked $\frac{7}{8}$-in. jackhammer steel is used. This light stoper can be handled easily in a narrow vein, and the special features have resulted in much faster drilling, as, with the ordinary stoper, considerable delay in the work was caused by stuck steel.

The ore is treated in a 70-ton, all-sliming, countercurrent cyanide plant requiring about 48 hours' contact in agitators, plus the contact in the grinding circuit and primary thickener. Results obtained indicate that a recovery of 96 per cent of the silver and 94 per cent of the gold will approximate standard practice.

From the 100-ton crude-ore bin on the headframe the ore feeds into a jaw crusher; thence onto a 181-ft. conveyor belt running to the fine-ore bin, from which another conveyor takes it to the ball mill, where cyanide and low-grade mill solution are added. From the ball mill the pulp passes to the classifier, where milk of lime is added.

The classifier rake product is returned to the ball mill, and the overflow to the primary thickener. The latter's overflow, which contains over 90 per cent of the silver and 85 per cent of the gold, goes to the pregnant solution tanks, while the pulp is passed through three agitators to a five-tray washing thickener.

In the first agitator the pulp is diluted with barrern solution from the barren-solution tanks. After passing through the agitators it enters the top tray of the five-tray thickener and passes through the trays and out to the tailings pond.

Fresh water as a wash is added to No. 5, the bottom tray, and barren solution is added to No. 4 tray. These solutions gradually increase in precious-metal content as they pass from the bottom to the top tray and into the mill solution tank while the descending pulps are thoroughly washed. The pregnant solution is precipitated in a 300-ton Merrill-Crowe precipitation filter press unit and the precipitate melted and the bullion shipped to the mint.

The only serious difficulty encountered at the beginning of the operation was the slow settling of the slimes causing the thickeners to be overloaded, resulting in a reduced tonnage, but this difficulty has been largely overcome by more careful operation of the thickeners. To date the addition of starch to aid settling has not proved beneficial. The addition of 0.4 lb. of litharge per ton of ore appears to have definitely improved both gold and silver extraction. The cyanide strength is carried at 3 lb. per ton and the alkalinity at 1 lb. of CaO per ton of ore. Cyanide consumption averages about 5.4 lb. per ton and lime about 15 lb. per ton. Average grind is 65 per cent minus-200 mesh. The tailings produced by the plant contain approximately 37 per cent solids.

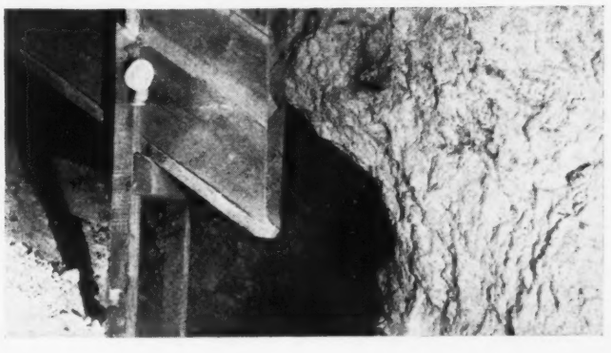
An abundant supply of water was obtained at 60 ft. depth in an 8-in. well at Sand Springs. About 25 g.p.m. is pumped to a 42,000-gal. storage tank through $3\frac{1}{2}$ miles of 3- and $2\frac{1}{2}$-in. casing against a head of approximately 850 ft.

Power for the mill is generated by two units. Each consists of a six-cylinder, 7x10-in., 190-hp., Cummins diesel engine connected to Westinghouse generators. One unit carries the entire mill load.

At the pump station a 15-hp. General Motors single-cylinder diesel en-

Looking up a stope on 200 level. One of the wings which diverts the ore into chutes

A stope chute on the 200 level east, of Summit King. Note its light construction



Summit King Mines, Ltd., Operating Data—April 1940

Expense Summary		Per Ton
Development		$0.60
Mining		1.29
Crushing and milling		2.90
Shipping		0.16
Overhead and general		2.58
Total		7.53
Tons treated		1,731
	Gold	Silver
Mill heads	0.214	18.70
Average assay of tails	0.026	1.04
Calculated recovery, %	87.8	94.4

gine is connected by shaft to a Worthington deep-well pump delivering to a 700-gal. tank, from which the water is pumped to the mine by a $2\frac{1}{2}$x$3\frac{1}{2}$-in. Deming triplex pump, belt-connected to a pulley on the diesel engine. This engine is equipped with a control device which cuts off the fuel supply in the event that the engine becomes overheated due to lubrication trouble. A red light in the mill goes on when the water ceases to flow into the storage tanks, indicating trouble in the pumping system.

The prospecting equipment installed for use in the mine proved so satisfactory that it was thought unnecessary to replace it with electric equipment.

Compressed air is furnished at a rate of 325 c.f.m. by a Sullivan Class WL60 compressor, V-belt driven by a 79-hp., six-cylinder, Cummins diesel engine.

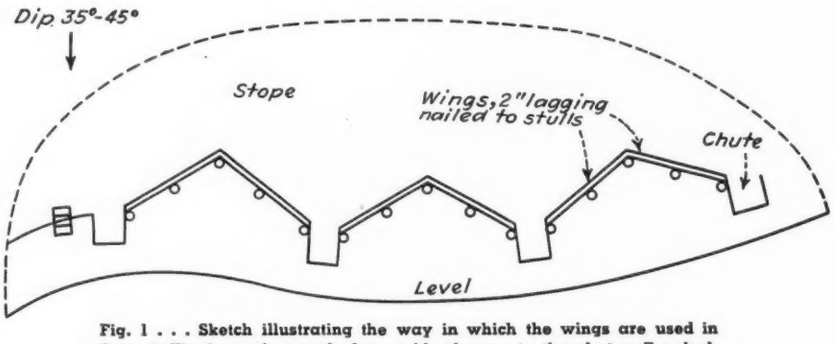


Fig. 1 . . . Sketch illustrating the way in which the wings are used in Summit King's stoping method to guide the ore to the chutes. Two-inch lagging is nailed to stulls. Drifts are not timbered or lagged

The shaft is equipped with a single-drum, PJ 112 Sullivan prospecting hoist, having a 3,000-lb. lift at 200 f.p.m., powered with a 30-ft. Buda gasoline engine. With this hoist 80 to 90 tons is hoisted per shift.

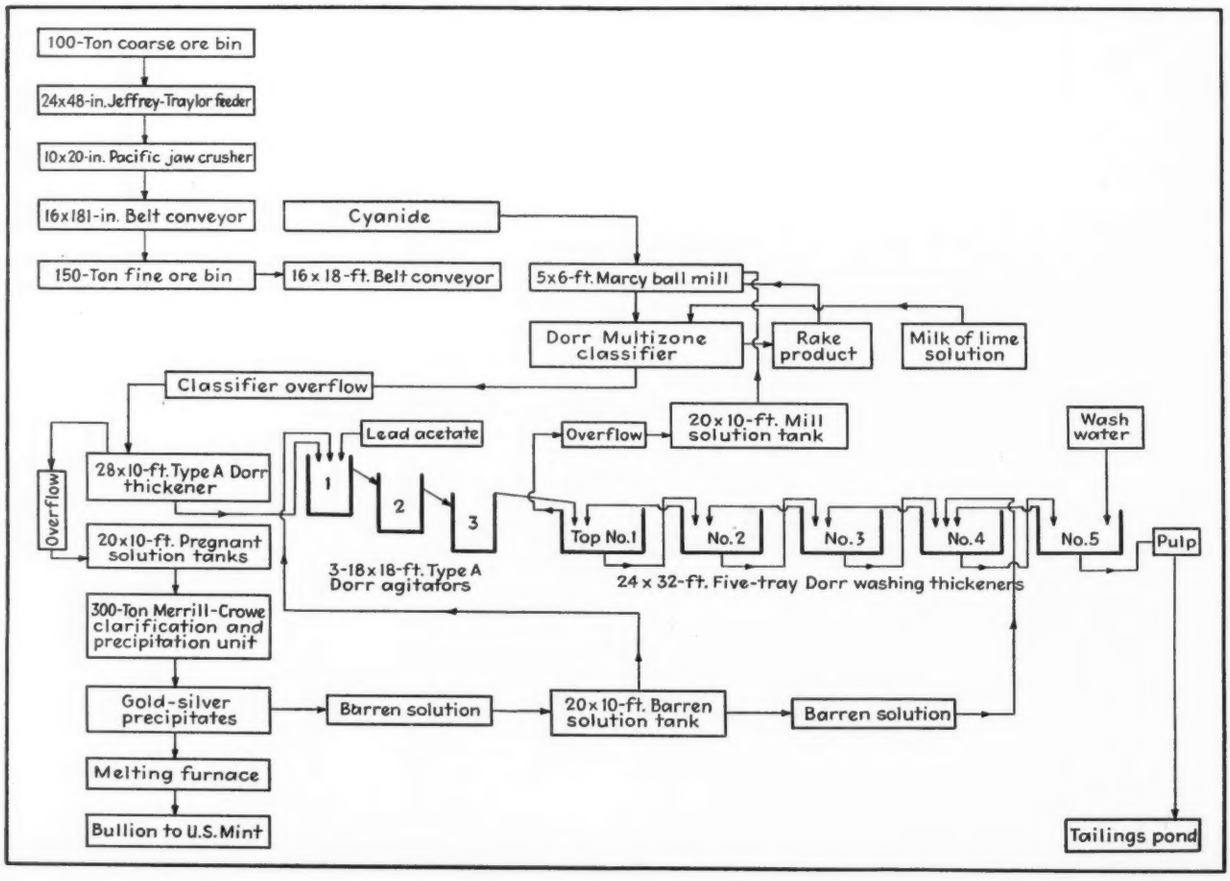
Southwestern Engineering Company built the mill, power plant, and water system on contract for $119,000.

Staff employees consist of manager, mine superintendent, night shift boss, a mill superintendent who takes care of all mechanical work, an engineer who assists in the mill, office manager, and stenographer.

Two men per shift are employed in the mill, and one extra man is employed on the day shift to take care of the tailings dump and other odd jobs. At the mine approximately 20 men are employed on surface and underground. Including all mine and mill labor, 2.3 tons per labor-shift is obtained.

The difficulties contingent to the practice in a new plant are rapidly being adjusted and in a few weeks the plant will have obtained or bettered the capacity of 70 tons a day and recovery of 94 per cent gold and 96 per cent silver for which it was designed.

Fig. 2 . . . Summit King's 70-ton cyanide plant is an all-sliming countercurrent installation working on this flowsheet



Guysborough Is Producing 600 Oz. of Gold Per Month

This outstanding small-scale enterprise in 80-year-old camp of Nova Scotia is treating 100 tons of ore per day. Mine is the property of Ventures, Ltd.

R. Charlick
General Superintendent
Guysborough Mines, Ltd.
Goldenville, Nova Scotia

SHERBROOKE gold district, in which is situated the property now being worked by Guysborough Mines, Ltd., a subsidiary of Ventures, Ltd., of Toronto, lies in Guysborough County, Nova Scotia, two miles west of Sherbrooke and near the northwest arm of St. Mary's river. It is 90 miles east of Halifax, from where it is reached in summer by steamer. It is also connected by daily stage with Antigonish, 40 miles away on the Canadian National Railway. Frequently it is spoken of as the Goldenville district, from the name of the village that sprang up here on the discovery of gold.

This district may be regarded as the most important one of the Province, its production having exceeded that of any other. One of the earliest discovered, it quickly became an important producer and for twenty years made large returns, in several years exceeding 7,000 oz., and in 1867 reaching the high mark of 9,463 oz. It passed through a period of comparative quiescence during the eighties and early nineties, after which it again became the scene of renewed activity and rose to the first rank among the producing districts.

Upon the discovery of gold in 1861 a surveyor was sent in, areas were laid off, prospecting was vigorously carried on, and soon the district was a live and energetic camp. The leases, or areas, as they were termed, were 50 by 250 ft. in extent. After sorting out the waste rock, each lessee took his quartz to a central mill for treatment.

Today, in an area about one mile long by a quarter wide, there are 367 shafts and pits of depths varying from a few feet to 700 ft. on the incline. From old maps and records it is estimated that 22,000 ft. of shaft sinking was done.

After many promotions, reorganizations, and amalgamations, mining was at its lowest ebb when, in 1934, an examination was made by Ventures, Ltd., which reopened the property. The old workings were dewatered and cleaned out and lateral development was started. For some time indications were that the ore was low in grade, patchy, and not in very large quantities. No trustworthy records of previous work were available and the picture was most depressing. The parent company persisted in its endeavors and in June, 1935, a high-grade shoot was found on a vein which had in previous times given considerable ore. From this time forward the mine managed to pay its way. New equipment was purchased as it could be afforded and the mill tonnage was raised as ore could be found to supply it.

For the year 1939 operating profits were approximately $65,000 and in June of this year the first dividend of 2½c. per share was declared. At this time production averages 600 oz. of gold a month.

During the last four years increased efficiency has enabled the company to raise the wage scale gradually about 40 per cent, and it is worthy of note that each increase has resulted in lowering operating costs.

Medical aid, group life and sickness insurance, and various forms of recreation have been instituted and these efforts have been more than repaid by the splendid spirit of cooperation and goodwill existing between the company and its employees.

During the whole period of operations we have received courteous assistance from the Provincial Department of Mines, which is making every endeavor to expand the metal mining industry of Nova Scotia.

Geology—The general topography of the Goldenville district is similar to that in some parts of northern Ontario and Quebec. Information from test pits and shafts formed the basis for the excellent geological map of the district prepared by E. R. Faribault some years ago.

The rocks consist of sedimentary beds of gray or greenish-gray altered sandstone, or quartzite, locally called the Goldenville formation. Interstratified with the quartzite are numerous beds of slates or argillites of different varieties, from a fraction of a foot to several feet in thickness.

A granite boss, probably of Devonian age, 2 by 4 miles in area, cuts the sediments 3 miles east of Goldenville. Its general course suggests that it roughly crosscuts the bedding of the sediments and has not simply welled up under the arch of the anticline. Its relation to the gold is obscure.

The 75-odd veins in the district are found on the limbs of an asymmetrical anticline running east and west. The anticlinal axis pitches west near the mine, but approximately 1½ miles east, it pitches east, thus forming a dome. The south limb is nearly vertical and in some cases assumes an overturned position at depth. The north limb dips at about 45 deg. All veins of importance are quartz "leads" following the bedding, usually in or at the sides of slate bands. Width of quartz has little bearing on the gold content of the veins.

The mine is situated on the south limb of the anticline and mining is carried on mainly on this flank, although exploration is under way on some leads north of the anticlinal axis. All leads strike almost due east-west except at the west end of the mine, where they begin to swing towards the "nose" of the anticline with progressively flattening dips. Two major drag-folds extend in a northwesterly direction from the anticlinal "nose."

Within these leads ore of minable grade is restricted to shoots, the irregularity of whose size, shape, and rake has proved the chief difficulty in development. The shoots on various leads are staggered so as to make rough zones running northwest-southeast across the strike of the leads themselves. The individual shoots almost all pitch east, although the angle is variable, with the result that the zones of shoots have a rough northeasterly dip. The extent of the shoot zones is limited both by the altitude of the beds and large areas of pinching caused by unknown external forces.

Arsenopyrite is the most abundant mineral in the ore, occurring as isolated crystals in quartz, quartzite, and slate, as well as massive in quartz. Minor amounts of pyrrhotite, chalcopyrite, galena, and sphalerite are also present. The gold, which is coarse and free milling, occurs in various kinds of quartz, sometimes associated with sphalerite and galena.

Engineering—All information which is of present or possible future use is noted and recorded by the engineering department. Full twenty-scale geological plans, longitudinal sections, and, where necessary, cross-sections are kept. Development work is recorded daily by means of face maps

Panorama of the mill, shafthouse, and other surface plant and staff residences of Guys-

or notes, particular attention being paid to changes in structure, such as dips, strikes, angulars, and widths of quartz, and to visible gold.

Due to the unreliability of channel sampling, all visible gold in stopes and drifts is plotted on maps, giving fairly reliable assay plans.

Areas of relative compression, causing pinching of the veins, are mapped on plans and sections, by means of which the areas favorable to ore deposition are delimited. Diamond drilling is utilized in this work.

This information is used in planning the development and mining schedules. The problem of developing ore can be readily appreciated when it is realized that four or five development machines are necessary to keep ahead of the six stopers. An average of 25 per cent of development work in ore is considered satisfactory, even though some of the ore so developed may only go 50 ft. or less above the drift backs. Furthermore, the fact that it is often necessary to mine 3 or 4 ft. (due to strike faulting along the walls of the slate bed) to break a vein 2 to 3 in. wide requires that the utmost caution be used in estimating grades. A crosscut traversing a distance of 100 ft. may cut half a dozen veins showing every indication of being possible ore carriers; the choice of which to work and which to leave alone is a matter of judgment and experience.

Mining and development—The mine is serviced by a three-compartment vertical shaft 15 ft. 6 in. by 6 ft. outside the timber, extending 627 ft. Hoisting with balanced cages through two compartments is carried on, using a Canadian Ingersoll-Rand type PEI 24x36-in. double-drum hoist. Levels are established at 160, 260, 400, 500, and 600 ft., although active work is in progress only on the last three. Pumps operate on the 260, 400, and 600-ft. levels. Surface and all levels are connected by telephone.

Drifting and crosscutting is carried

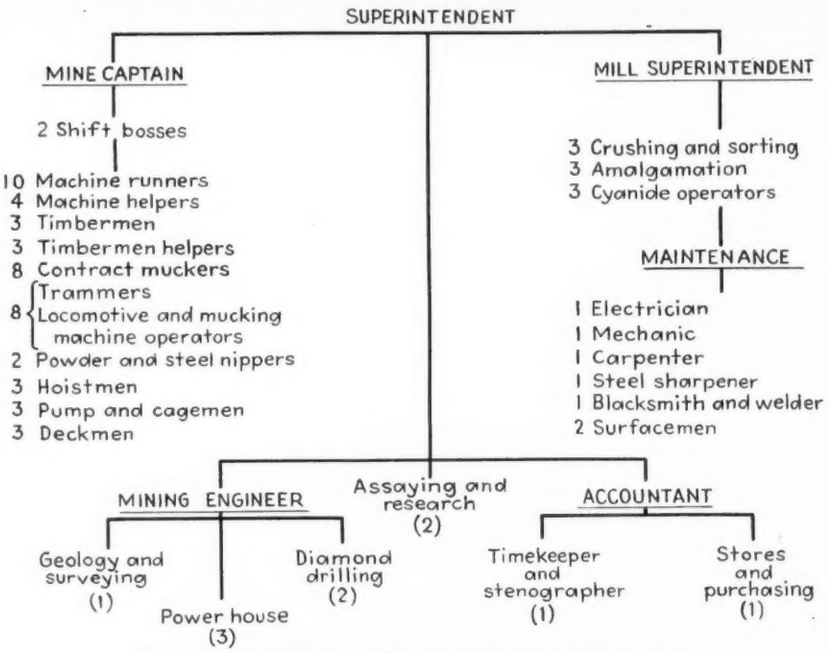


Fig. 1. . . . Organization chart of Guysborough Mines, from the position of general superintendent down. The crew shown is that steadily employed. Extra men may be taken as required

on by means of Climax 3½-in. drifters with standard bar equipment and 1-in. quarter-octagon hollow steel. Approximately 23 holes are drilled on each face, using a five-hole diamond cut, blasted separately. A 7-ft. square-up produces an average advance of 6½ ft. Powder consumption naturally varies with the type of ground being broken, one and one-half cases per round being the average, using C.I.L. 40 per cent Forcite and 70 per cent Driftite in proportions decided upon by the runner. During 1939, 5,589 ft. of lateral development cost an average of $8.50 per foot. This figure includes its full share of mine overhead. All development work is operated on a bonus footage contract basis.

Raises are driven with 3-in. Climax stopers using 1-in. quarter-octagon steel. Pockets and chutes are installed where the heading is going over 40 ft. Average size of opening is 4 by 6 ft. requiring 18 to 19 holes using 6-ft. steel and a five-hole burn cut. Approximately 110 sticks of C.I.L. 30 per cent Forcite are necessary to produce an advance of 5 ft. Electric delay-action caps are used after the face reaches 50 ft. Average cost per foot for 1939 including mine overhead was $8.75.

Stoping is of a simple shrinkage type. The irregular character of the oreshoots necessitates many modifications of standard stoping practice. Long boxhole raises and pillars are utilized where necessary to follow the upward rake of the ore. Widths vary from 24 in. to 6 ft. according to the belt being mined. Where previous

borough Mines, Ltd., at Goldenville, Nova Scotia. A new enterprise in an old district

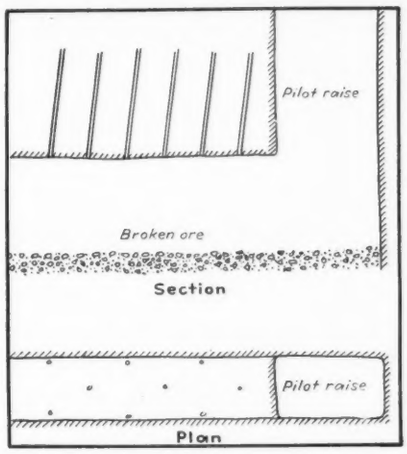


Fig. 2. . . . Stoping is of a simple shrinkage type. The sketch shows the arrangement of the holes, in plan and section

experience has shown the walls of a belt inclined to slab off, boxholing is used driving a sublevel across the tops. On other belts stull and lagging timbering is used. Chute openings are spaced at 15-ft. centers. Chute design is standard. Manways of convenient size are raised with each successive breast mined. Wherever possible a pilot raise is driven through to the level above, thus providing good ventilation and disposing of the necessity of drilling a "cut" on each breast. The stope is also serviced by this raise after the halfway mark has been reached. Stope holes are driven 7½ ft. with 3 in. Climax stopers as shown in an accompanying sketch. Holes are loaded with six to seven sticks of C.I.L. 30 per cent Forcite, 1⅛ in. by 8 in., using five to seven wooden spacers 5 in. long. Every hole is tamped with wood-pulp paper, a by-product of a local pulp and paper mill. This tamping is kept sufficiently moist by storage underground. Blasting is done by the runner. Each stope runner is "set up" at the beginning of each shift by a timberman, who also helps blast at the end of the shift. Standard safety tape fuse is used in all stopes. Where the holes to be blasted total 24 or less, 8-ft. fuses are used; from 25 to 35 holes a 10-ft. fuse is provided. Powder, spacers, fuses, and tamping are delivered to the manway by a powder monkey. Tonnages per machine shift vary according to the widths mined. Average tonnages are: 24 in., 10 to 12 tons per machine shift; 36 in., 18 to 20; 48 in., 25 to 30; 60 in., 35 to 40; and 72 in., 50 to 60.

Wherever possible stopes are backfilled with development waste after being emptied. When conditions prevent this, the stope is scaled and back spragged while being drawn. During stope preparation mucking is done mechanically on the backs blasted down, using an Eimco-Finlay loader. The mucking machine is also used where two development faces in close proximity make it economical.

Transportation—Hand and electric locomotive tramming is used with 16-cu.ft. end-dump cars equipped with roller bearings and chilled-tread wheels. A Greenbat electric trammer is used on long haulages. Cars are caged and hoisted to top deck bins.

Safety—Safety rules developed by the company in addition to standard regulations are strictly enforced. All faces and breasts to be mined must be washed and checked for missed holes or bootlegs, containing powder, before drilling. Men found working under loose rock are penalized—a second offence draws dismissal. Blasting alone is prohibited. All men are provided with Edison cap lamps, and in addition must wear approved hard-toe boots, gloves, hard hats, and goggles. Mine captain, shift bosses, and several others are trained in first-aid work and every effort is made to develop safety-consciousness among the men. Dust and fume control is exercised as much as possible by injecting water at the air nozzle while blowing smoke.

Milling.—Milling is accomplished by means of stamp-battery amalgamation, followed by table concentration, and cyanidation of the resulting concentrates.

The ore, the average grade of which is about 0.2 oz., is hoisted to the surface by caged cars and is dumped through a 6-in. grizzly into a small bin, from which it is fed to a shaking sorting table. Twenty to 25 per cent of the ore is discarded here, the remainder being crushed to minus 1½ in. in a 6 by 14-in. jaw crusher. The crushed ore is conveyed to the four 60-ton mill bins by means of a skip and hoist. Separate bins for each 10 stamps gives flexibility, whereby mill testing can be accomplished without interrupting production.

Mill capacity is 100 tons of feed per 24 hours, grinding being done by means of 40 950-lb. stamps in batteries of five, belted by countershafts to a 100-hp. General Electric synchronous motor. This motor being 20 hp. underloaded provides power factor correction.

Practically all amalgamation takes place in the mortar boxes for three reasons: the ore is free milling, the gold is coarse, and the water jets are placed in front of the battery and below the screen in such a way that the pulp is kept loose between the dies. Of the gold, 95 per cent is caught in the mortar box. The remainder passing through a 24-mesh screen is caught on amalgamation plates and in an amalgam trap. The plate tails average 0.012 oz. per ton.

Plate tails are laundered to two Wilfley tables which produce approximately 1 ton of concentrate per day averaging 0.40 oz. of gold per ton and having an arsenical content of 27 oz. Final tails are less than 0.01 oz. per ton.

Current concentrates plus some con-

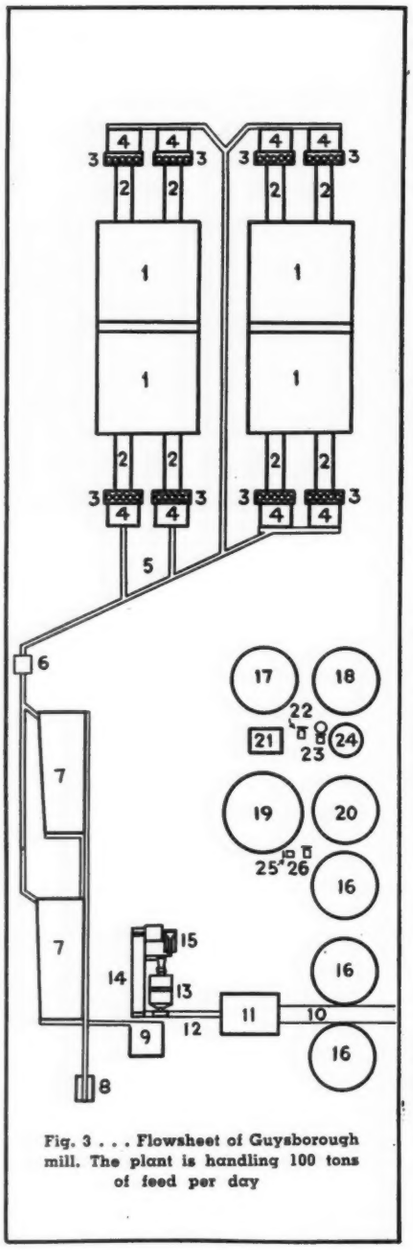


Fig. 3 . . . Flowsheet of Guysborough mill. The plant is handling 100 tons of feed per day

LEGEND

Amalgamation

1. 4 60-ton ore bins
2. Ore feeders
3. 40 950-lb. stamps
4. 8 4x3-ft. amalgamation plates
5. Plate tail launder
6. Amalgam trap

Concentration

7. 2 Wilfley tables
8. Automatic tailings sampler
9. Table concentrate bin

Cyanidation

10. Tramway from outside concentrate stockpile
11. Concentrate bin
12. Feed belt
13. 30x36-in. Denver ball mill
14. 12-in. Denver high-weir type classifier
15. 2-in. Wilfley sand pump
16. 3 8x8-ft Denver (Wallace type) super-agitators
17. 8x10-ft. mill solution tank
18. 8x10-ft. pregnant solution tank
19. 10x6-ft. mill solution tank
20. 8x6-ft. barren solution tank
21. Denver clarifier
22. Denver solution pump
23. Denver zinc cone and pump
24. Denver precipitation unit
25–26. Denver solution pumps

centrate from the stockpile are reground to 94 per cent minus-200 mesh and then treated in a 5-ton Denver Equipment batch cyanide plant, with 75 to 85 per cent of the gold being recovered. Variations in recovery are caused by the fouling of solutions from the treatment of oxidized stockpiled material. Sulphocyanate determinations are made and barren solution is bled off as necessary. Reagent consumption is 10 to 15 lb. of lime and 1½ to 2 lb. of sodium cyanide per ton of concentrate. Solutions are held at 0.3 lb. NaCN and 0.25 lb. CaO. This plant has been in operation for only the past two months, so costs would be misleading.

Mill clean-ups are made four times monthly. The material between the water fronts and the dies is taken out and placed in a 24x36-in. amalgamation barrel, a small quantity of lye is added and sufficient quicksilver to insure complete recovery of the fine gold. The consumption of quicksilver amounts to about one flask yearly.

Amalgam is retorted and the resulting bullion, which has a fineness of 945 gold and 35 silver, is shipped to the Royal Canadian Mint at Ottawa. Bullion from the cyanide plant is about 700 fine.

Plant and Equipment.—When the property was taken over in 1934 all equipment was obsolete. The only buildings were the mill building, which housed the mill, mine dry, heating plant, machine shop, and compressor house; a small log building for steel sharpening and blacksmith work; an office building, and a combination store house, refinery and assay office.

During the past five years the necessary buildings have been erected, obsolete machinery has been replaced with new and up-to-date equipment and the various maintenance departments have been equipped with the latest tools.

The stores department stock is maintained at approximately $25,000. Spares for all wearing parts of the various machinery are kept on hand ready for immediate placing into service as required, together with the usual stock of mining supplies.

The hoist is a Canadian Ingersoll-Rand, Class PE-1, 24x36-in. double-drum, with semi-magnetic control. Overwind and power-failure protection are provided. Two cages are operated

Table I—Operating Costs Per Ton Hoisted

		%
Mine development	$1.484	32
Stoping	1.514	33
Milling	0.575	12
Mine office and supervision	0.462	10
General expense at property	0.394	9
Head office expense	0.038	1
Outside exploration	0.143	3
Total	$4.610	100

Table II—Mining Costs

Tons of ore hoisted 38,987	Drifting and Crosscutting	Raising	Stoping
Machine men and helpers	$0.228	$0.027	$0.197
Muckers	0.197	0.008	0.076
Trammers	0.005	0.003	0.112
Explosives	0.280	0.034	0.398
Timbering	....	0.022	0.125
Cars, track and pipe	0.039	0.005	0.052
Compressed air	0.025	0.004	0.038
Steel and sharpening	0.056	0.010	0.079
Drill maintenance	0.048	0.007	0.066
Hoisting and dumping	0.085	0.013	0.118
Pumping	0.030	0.005	0.043
Miscellaneous supplies	0.013	0.001	0.001
Supervision	0.049	0.008	0.067
Mine general expense	0.159	0.022	0.217
Backfilling	....	....	0.015
	$1.214	$0.169	$1.514

The balance of mine development cost is made up of: slashing, $0.023 and diamond drilling, 0.078 per ton.

Table III—Milling Costs

Stamp milling	$0.327
Crushing and sorting	0.109
Conveying	0.031
Refining	0.003
Concentrating	0.015
Mill general expense	0.090
Total	$0.575

Table IV—Mine Office and Supervision

Office salaries and expenses	$0.167
Engineers' salaries and expenses	0.103
Warehouse expense	0.028
Office supplies and sundry expense	0.048
Telephone and telegraph	0.025
Travelling expense	0.023
Assaying	0.057
Donations	0.006
Legal fees	0.005
Total	$0.462

Table V—General Expense at Property

Operating camps	$0.013
Taxes and leases	0.066
Insurance	0.059
Fire protection	0.007
Handling explosives	0.024
Lighting	0.029
Surface maintenance	0.077
Building maintenance	0.065
Equipment maintenance	0.005
General engineering expense	0.002
Surface supervision	0.041
Water supply	0.006
Total	$0.394

in counterbalance. Two 72-in. bicycle-type sheave wheels are mounted 70 ft. above the surface, on a shaft house of heavy, local, framed timber. Back-legs are a modified Warren truss, each one hoisted into place as a unit.

The compressor is a Babcock Wilcox, Type V2S, vertical two-stage unit of 750-cu.ft. per minute capacity, driven by a 150 hp. Canadian General Electric synchronous motor. Air pressure is recorded graphically on a Taylor meter. A Gardner-Denver, horizontal-type, single-stage, 500 cu.ft. machine acts as a standby.

In the blacksmith shop is a Sullivan oil-fired furnace, a Climax sharpener, and a Holman hot-miller, as well as the usual blacksmith equipment.

The machine shop is equipped with a 20-ft. lathe with 19-in. sweep; a 30-in. shaper; a 30-in. circle drill press; a power hack saw; a power grinder; a 6-in. plate shear; a 4-in. Oster pipe threader, and electric and acetylene welding equipment. The carpenter shop is equipped with the customary tools, together with an electric saw, a planer, and a Foley saw filer.

The assay laboratory is completely equipped to make ordinary metallurgical determinations. The equipment includes a Braun crusher and pulverizer, a Hoskins-type electric furnace, with concrete replacing the usual iron casing, a Roller Smith precision balance, and a Cenco analytical balance.

In the testing laboratory Denver flotation cells, tables, a jig and a ball mill provide facility in any necessary testing, as well as microscopic work.

Standby power, for use in case of power failure, is provided by a Sterling Petrel, 6-cylinder, 125 hp. engine, belt-connected to a 75-kva. generator. This unit can be synchronized with the main power plant.

In addition the mine buildings include the office, store house, heating plant, diamond-drill core shack, electric shop, and salvage shed.

The company operates its own hydro-electric plant at Liscomb Falls, 9 miles southwest of the mine. Power is generated at 440 volts by two Westinghouse alternators, 200 and 205 kva. respectively, driven by a 26-in. horizontal Barbour wheel, and is transmitted at 11,000 volts, being stepped down to 440 volts for use at the property.

At the head of Guysborough Mines, Ltd., is Thayer Lindsley, president of Ventures, Ltd., of Toronto. H. S. Munroe is consulting engineer and D. R. Derry consulting geologist. The mine staff is composed as follows: R. Charlick, general superintendent; P. M. Hedley, mining engineer; E. Ashley, mine superintendent; A. C. MacKay, mill superintendent; H. E. Nauss, accountant; and E. O. Porter, assayer.

Surface plant and cyanidation equipment of Goldacres mine, in Lander County, Nevada, about 30 miles from Beowawe

Goldacres Mine Supplies 35-Ton Cyanide Plant

E. J. Bumsted
Beowawe, Nev.

GOLDACRES MINE is in Lander County, Nev., about 30 miles from Beowawe and opposite and 12 miles distant from the old camp of Cortez, once a celebrated producer of silver. It was discovered in 1922, but no work was done, except desultory prospecting, until 1935, when A. E. Moynahan, of Denver, Colo., arranged for its purchase and the following year designed and erected a mill, and brought the property into production for the first time. With the aid of his assistant, Harry Treweek, the plant was put in operation and has continued running to date, and great credit is due these men for organizing a simple enterprise.

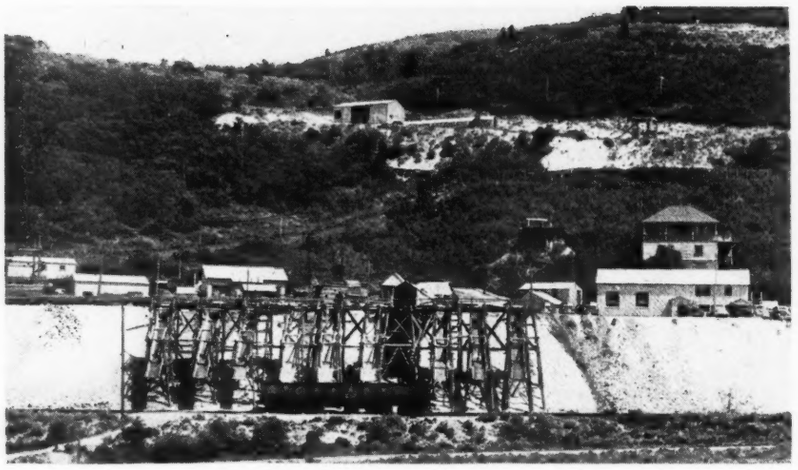
The orebody lies within an uptilted and highly altered limestone bed, much fractured and dipping at an angle of 30 deg. from the horizontal. The footwall is blue limestone and the hanging wall is thought to be porphyry, though it is so oxidized and altered that its original character is in doubt. This so-called porphyry contains no values. The present profitable ore lies in an irregular sheet parallel to the wall, but neither at the contact nor at any fixed distance from it, and waste and ore all look alike, the assay alone serving to make the distinction.

Mining is done selectively with the drill only and no attempt is made to sort by hand. Close sampling enables the miner to stay with the ore, and this is the only rule followed. Slips, minor faults, and geology mean nothing; assays, everything.

The milling plant is simple and consists of ore bins, a gyratory crusher (vintage of 1900) four 15x9-ft. leaching tanks, three zinc boxes, and the necessary storage tanks.

The ore as it comes from the mine is crushed to minus 2 in. and trammed directly to the leaching tanks without further breaking. It is then leached in a 1.5-lb. cyanide solution, given a water wash, and discharged by hand at a contract cost of $12 per tank. The tanks hold 70 tons of ore, and the complete cycle is seven days. With each charge of 70 tons, 250 lb. of lime is added. Water consumption is 0.15 tons for each ton of ore. The mill capacity is 35 tons per day. Recovery is 85 to 89 per cent, all of it being in gold.

Water is obtained from a well 3 miles away and 700 ft. below the plant. It is hoisted 80 ft. and then delivered to the property by tank truck at a cost of 75c. per ton. The daily consumption of water at the mine is 1.3 tons and for the camp the same.



Park City Consolidated's surface plant and loading bins

Drainage and Development At a Utah Mine

Opened in 1939, Park City Consolidated has solved difficult drainage problem with churn-drill holes and has shipped 425,000 tons of ore to date

Gloyd M. Wiles*, Allan R. Reiser, R. P. Diehl, and L. W. McDaneld

EMBRACING 652 acres, the property of Park City Consolidated Mines Company is in the northeastern part of the Park City mining district, in Utah, on the eastern slope of the Wasatch range, 30 miles southeast of Salt Lake City. Although the company's holdings are 1½ miles from the heart of Park City, they lie within the city limits. Branch lines of the Union Pacific and the Denver and Rio Grande Western railways serve Park City. The two roads jointly own a two-mile spur which terminates at the loading tipple at the mouth of the mine adit. Although the elevation at this point is 7,200 ft. above sea level, climatic conditions are not usually severe.

Mineral was first discovered in this district in 1869. To date approximately $70,000,000 in dividends have been realized. Park City Consolidated Mines Company was incorporated in 1928 and started development in the latter part of the year. Early in 1929 ore was found in sinking No. 1 shaft, at a depth of 269 ft. To June 1, 1940, net smelter returns, after freight and treatment, amounting to $3,080,564.43 were paid for 424,716 tons of ore averaging 15.57 oz. silver and 0.0367 oz. gold. Minor amounts of zinc and lead were also present.

A comprehensive report on the geology of the district was compiled by J. M. Boutwell in U.S.G.S. Professional Paper 77. The sedimentary rocks (limestones, shales, sandstones, and quartzites) which are Pennsylvanian through Triassic in age, have been uplifted and folded into a dome, on the northeast end of which is the property of this company. These sediments dip 15 to 18 deg. northeast, and have been faulted and intruded with diorite, diorite-porphyry, and andesite. All mineralization is replacement in type and occurred at the same time as or after the intrusive action.

Two types of ore deposits are found in the district: fissure veins, which are principally confined to the quartzites underlying the Park City limestone, and bedded limestone replacements. The fissure ores are generally high in silver, with minor amounts of gold, zinc, and lead; and the bedded deposits within the Park City limestone are high in lead, zinc, and silver, with minor amounts of gold and copper.

The ore of Park City Consolidated has been confined to fissure deposits and three of the five fissures discovered to date have been productive, with favorable indications disclosed in the other two.

In thickness the faulted zones vary from 30 to 100 ft. The veins lie within the fractured mass, generally nearer the hanging wall but not adjacent to it, resulting in weak, highly fractured walls on both sides. The veins strike northeast-southwest, dip 45 to 70 deg. southeast, and vary in thickness up to 26 ft. The fractured quartzite walls are also weakly mineralized, so that detailed geologic mapping is necessary to avoid missing parallel shoots which occur at irregular intervals along the dip and strike. The ore masses themselves in the main vein also occur irregularly along the strike and dip and have varying thicknesses and grades. It will be appreciated, therefore, that careful sampling and close supervision of mining and timbering are essential to maintain grade control.

No post-mineral faulting of importance has been noticed, the veins never being offset more than a few feet. Values are seldom found nearer the surface than 200 ft. and generally are discovered more nearly 400 ft. down the dip.

Dewatering and Development—The eastern end of the district has been drained by the Ontario drain tunnel of the Park Utah Consolidated Mines Company to an elevation of approximately 6,300 ft. above sea level. The working entrance of the Park City Consolidated is the 200-ft. adit 7,200 ft. above sea level, already mentioned. The 900-ft. level throughout the property, therefore, is drained by the Ontario tunnel. Consequently, this 900-ft. level has become the most important development and transportation level. (See Fig. 1.) Immediately below this level, water is met and with each foot of vertical depth an additional 10 g.p.m. of water is being developed within the faulted zone containing the vein.

Another problem was presented in connection with underwater development in addition to that of drainage, in that the quartzitic fractured mass surrounding the vein was so minutely crushed that it reacted almost like sugar where openings were attempted below previously drained areas. Sinking was first attempted down the dip of the vein, but it was soon learned that the ground could not be held when wet, so a vertical winze was started from the 900-ft. level in the solid

*Development and mining by Gloyd M. Wiles, vice-president and general manager; geology by Allan R. Reiser, chief geologist; electrical systems by R. P. Diehl, electrical engineer; cost accounts by L. W. McDaneld, accountant.

quartzite, forming the footwall of one of the faults. Although no difficulty in supporting the solid quartzite was encountered here, water flow gradually increased to 750 g.p.m. before 300 ft. of sinking was completed. This made sinking costly, as much operating time was lost in holding the water at the bottom of the shaft by means of the 40-hp. Cameron motor-pumps in use at the time. Direct labor and material costs exceeded $200 per foot for the last 20 ft. of sinking this 300 ft. of shaft, whereas total costs over the 300 ft. amounted to approximately $100 per foot. (No equipment or power costs used in connection with drainage are included in these figures.) Sinking was done with buckets and crosshead.

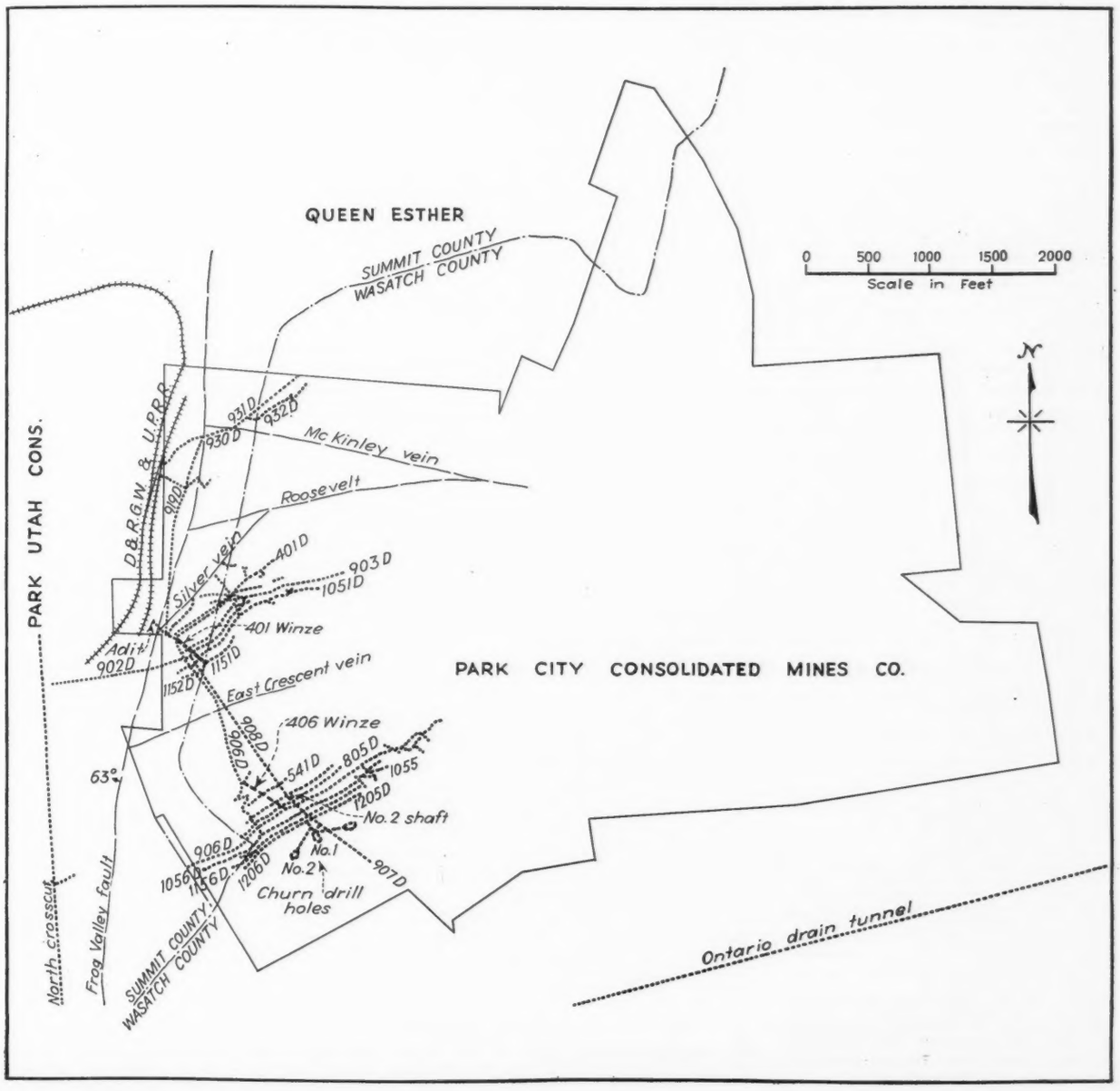
From these experiences, it was decided that a method of draining the fractured zone at depth in advance of all development should be attempted. After much deliberation, a 24-in. churn-drill hole was drilled from a location in the solid quartzite composing the hanging wall of the fault on the 1,050-ft. level to encounter the fractured zone 400 ft. vertically below the collar. The well was sunk to a total depth of 520 ft., where it bottomed in the solid quartzite footwall. All drilling was done with open hole and 19¼-in. inside-diameter casing was installed at the completion of the drilling. This No. 1 well developed approximately 1,400 g.p.m.

No. 2 well was then drilled 225 ft. to the southwest along the strike so that it would cut the fractured zone 525 ft. below the 1,050-ft. level. Solid quartzite footwall material was cut at 650 ft. This well developed 5,000 g.p.m. After three months of continuous pumping, the flow had diminished to 4,300 g.p.m. and the water table had dropped 175 ft. to the 1,300-ft. level. Additional recession of the water table is expected.

Byron Jackson submersible motors, direct-connected to the bottom ends of turbine pumps, which were suspended from the collars of the wells on 10x10-in. gage, spiral-welded pipe, joined with Victaulic couplings, were used. Development of No. 2 well showed that one pump unit was insufficient, so two 350-hp. submersible motor-and-pump units were suspended in series in the same well.

Sinking from the 1,200-ft. level to the 1,300-ft. level at a direct labor and materials cost of $70 per foot was carried on while the water table was being lowered. An average of 75 g.p.m. was pumped during this sinking, by means of a Byron Jackson deepwell turbine pump direct-connected to a 40-hp. vertical hollow-shaft motor

Fig. 1 . . . A map showing the property of Park City Consolidated Mines Company. The holdings total 652 acres



equipped with a Schutte & Koerting exhauster for automatic priming, or by Ingersoll-Rand pneumatic sump pumps. The sinking operation was conducted with the aid of a sinking cage and a mucking pan in lieu of the bucket and crosshead.

No difficulty was had in opening the fractured zone on this 1,300-ft. level, which would have been impossible without prior drainage.

Submersible pump-motor control is accomplished by Allen Bradley, automatic, full-voltage across-the-line starters protected by G.E. oil breakers. Float switches in the sump, into which these pumps discharge, automatically stop the submersible motors before the sump overflows and start them again at a predetermined level. An electrical device at the discharge of these pumps operates an alarm system to the surface indicating failure from any cause. Consequently, and since all pumps are automatically controlled, a daily inspection on the five operating days of each week suffices in place of continuous pump attendance.

The tandem pumps in No. 2 well have been electrically interlocked. Failure of one automatically stops the other. The lower pump starts first; a time-delay relay starts the upper after 15 seconds. Should the well run dry, a pressure switch stops both pumps. One float switch in conjunction with a hand-off-automatic pushbutton makes operation of the tandem pumps entirely automatic.

It is of interest to note, in passing, that at the time dewatering below the 900-ft. level was begun, the company had no connection with the Ontario drain tunnel, so that it was necessary to lift the water 900 ft. to the surface. This was accomplished by means of four single-stage, 75-hp., 1,200-g.p.m., 250-ft.-head Cameron centrifugal station pumps, all connected in series. Two were on the 900-ft. level and the other two on the 450-ft. level. Operation was fully automatic, being controlled by a float switch in the sump on the 900-ft. level. To prevent all the motors starting simultaneously, definite time-limit relays were employed to accelerate each unit before the succeeding unit was allowed to start. A pressure switch below the 450-ft. level prevented the pumps above this point from starting unless and until the water had reached them from the 900-ft. level units. (See the diagram of automatic control in Fig. 2).

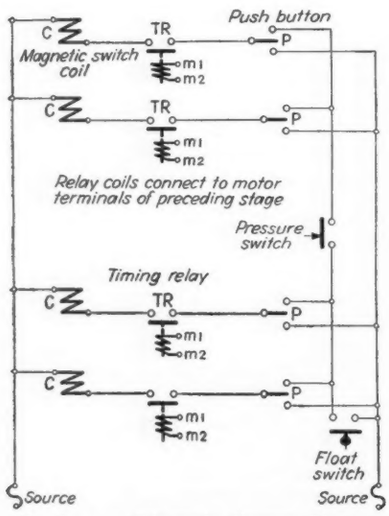


Fig. 2. . . . Schematic diagram illustrating the method of automatically controlling four centrifugal pumps in series used in lifting mine water 900 ft. to surface in the Park City Consolidated mine

Another innovation was in the use of three-conductor 60 per cent rubber-jacketed power cables having copper wires in the valleys for use as ground wires. These were specified by the mine and were used in lieu of the lead-covered type cable. Cables are supported on messenger wires by the use of cable rings.

While sinking, great difficulty was had with the windings of the sinking-pump motors. The quantity of water entering the shaft above the pumps was such as to defy every effort to keep them dry. Motors received new from the factory often failed before they had made a complete revolution. A system of winding was finally developed by our electrical engineer which was so satisfactory that pumps often dewatered themselves after being submerged to depths of 25 ft. or more. This winding has been produced in limited quantities for other properties and, at the insistence of some manufacturers, is now being furnished by the General Electric Company under the trade name, Salt Lake winding.

Mining—Drifts are driven in the vein by means of I-R Jackhamers, hand-fed Leyner drills, and auto-feed Leyners, depending on the type of rock met. Cross bars are used with the Leyner machines and an Eimco-Finlay loader is used for mucking where practicable. Often ore and waste are shot separately in drifts where the ore streak is narrow, in which case mucking is more cheaply done by hand. Also, drifts in isolated sections are hand-mucked. Power loading is never successful unless power tramming and an abundance of cars are available. Unless the loader can be used to clean out more than one heading per shift, the cost of power, maintenance, and depreciation involved in its use will be wasted, as the loader requires the use of two men, an operator and a trammer, whereas two muckers can clean out the round by hand, eliminating the power, maintenance, and depreciation cost.

Drifts are timbered with 8x10-in. or 10x10-in. posts, 8x10-in. or 10x10-in. caps, and 8x10-in. or 10x10-in. bridge caps through ore. Here the hanging-wall posts are battered and the footwall posts are stood vertically to facilitate chute installations along the footwall on the vertical posts. Sets are on 5-ft. centers and chutes on 15-ft. centers. All timber here, including lagging, is of Douglas fir.

Three-compartment raises are driven from level to level with a chute on each side of a manway. Caps are placed at right angles to the dip and strike, extending from foot to hanging and are of 8x8-in., 8x10-in. or 10x10-in. Douglas fir hitched in place against head and foot boards. Posts and girts are round lodge-pole pine and are spiked in place. Short spreader boards are spiked to the caps in place of framing to hold the posts in this direction. Similar sets are used in the stopes and locally are known as stringer sets. This method of open-stope support has proved most economical and permits better grade control, as caps are cut to fit the opening, whereas in the use of ordinary square-sets having prior framing, the timbermen are likely to fit the opening to the timber, particularly where picking of walls is so little effort. A stope or raise crew consists of a miner and a timberman, with the miner drilling and blasting for two sets while the timberman stands two sets in the opening made by the previous shift. A drift crew ordinarily consists of three men, a miner and two muckers, which advance a normal 6x8-ft. drift about 5 ft. per shift, with timber being installed later.

Blasting practice—Blasting is done with 1¼x6-in. No. 2 Gelamite except in wet places, where 30 per cent gelatin is used. This size stick, particularly in the case of Gelamite, gives an unusually high stick-count per case. Miners are "stick-count conscious," and a great saving is effected in this manner, especially since most difficulty arises

Organization and Crews

(Five-day Work Week)

General Manager and Vice-president
- 1 General mine foreman
  - 2 Shift foremen
    - 3 Shift or jigger bosses
      - 32 Hoistmen and general haulage (3 operating shafts)
      - 60 Miners and timbermen
      - 35 Muckers and trammers
      - 6 Mine repairmen
      - 2 Pipe and track men
      - 2 Nippers
- 1 Electrical engineer
  - 1 Electrical foreman
    - 3 Electricians
      - 2 Electrician's helpers
- 1 Master mechanic
  - 1 Mechanic foreman
    - 1 Steel sharpener and blacksmith
      - 1 Steel sharpener and blacksmith helper
    - 2 Carpenters (timber butchers)
    - 5 Mechanics
      - 3 Mechanic's helpers
    - 3 Watchmen-compressormen
- 1 Chief geologist and engineer
  - 1 Assistant engineer and draftsman
- 1 Office manager
  - 1 Warehouseman
  - 1 General secretary
- 1 Assayer
  - 1 Assayer's helper

A total of 175 employees used for production and development of 350 tons per day under usual operating conditions.

from overbreaking into the walls, which, as a rule, are softer than the vein. These small sticks of approximately 37 per cent strength, therefore, have effected twofold material savings by reducing powder consumption and by decreasing the overbreak, thereby improving the grade. No. 6 caps and fuse are used in dry places, whereas electric firing is required in wet headings.

Sampling—Sampling is done by the general foreman, the shift foreman, and the shift or jigger bosses on their regular rounds, as the ground is soft and only a few minutes are needed to cut a sample. This has increased the bosses' interest in grade control and saves engineering expense.

Grab samples are taken by all trammers from each car and separated according to working places. Additional grabs are taken by the top trammers for each railroad car loaded, so that daily income can be estimated. The crude ore is shipped to the United States Smelting, Refining and Mining Company at Midvale for concentrating, smelting, and refining. Daily assays of cuts made in the morning are out by 1:00 p. m., together with cuts made during the previous night. As much of the marginal material cannot be assayed by visual inspection, numerous samples must be quickly assayed to guide production.

Accounting—Timekeeping, payrolls, and cost accounts are maintained by one accountant and a general-purpose secretary and typist. Warehousing and purchasing are done by one warehouse man, who makes the disbursements, maintains stock cards, and sends orders through to the accountant for ordinary purchases. Equipment purchases and large or unusual orders must all be okayed by the management.

Time cards are made out by individual employees showing hours, job numbers, and the amount of timber or blasting supplies used. The payroll sheet has the account number or working place entered opposite the man's name instead of the hours worked where the usual eight-hour shift is performed. If more or less time is worked, then the actual hours are also shown. All costs for the day are accumulated from these cards and from the warehouse disbursement records, together with the general overhead costs, on a daily mine report showing the profit or loss for the day with details for each working place. The operating day closes at 8:00 a. m. and analyses of all job costs are available in the afternoon. Paydays are weekly, with disbursements being made by check on each Friday of the following week.

General books and payment for supplies and taxes are handled by one accountant at the general office in Ogden, Utah.

Mechanized Loading Aids These Small Operations

Mechanical shovels and scrapers reduce costs and increase output where system of mining permits their use. They likewise serve in mucking out headings

MECHANIZATION of underground loading in metal mines marks a trend in current practice that gives promise of modifying, if not revolutionizing, mining methods at many properties. Adopted widely at the larger mines today, after the mining industry has witnessed years of effort with steadily improving designs, loading machines are now being used in properties where production runs as low as 100 to 200 tons per day. Believing that an exchange of experience as to the use of mechanical loaders would benefit not only present but prospective users also, *Engineering and Mining Journal* invited a number of operators to contribute to a symposium on the subject. Below we publish a few replies, relating to a variety of underground conditions.

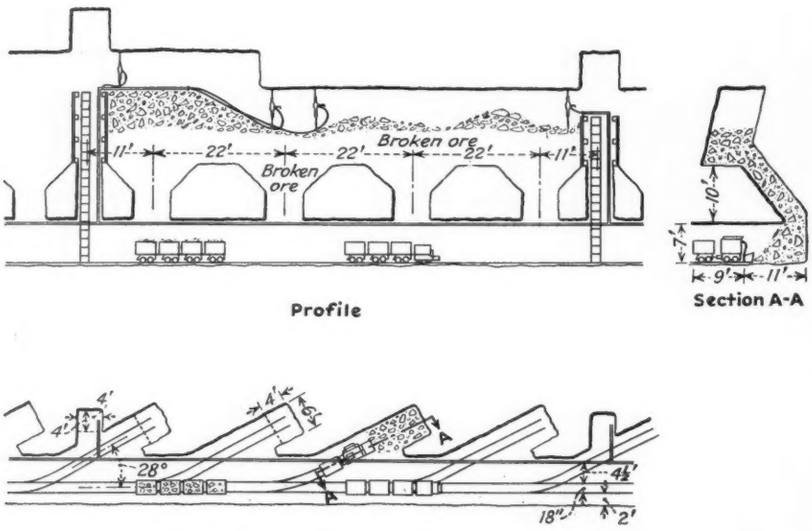
Black Hawk, at Mogollon, Adapts Mining Method to Shovel Loading

Lays out its 750-ft. level to get maximum advantage from recently acquired machine

Ira L. Wright
General Manager
Black Hawk Consolidated Mines Co.
Mogollon, N. M.

ON JAN. 12, 1940, we obtained delivery of a No. 12-B Eimco-Finlay shovel loader at the property of the Black Hawk Consolidated Mines Company, at Mogollon, N. M., and started using it on development work on our 600-ft. level. Conditions were not favorable for obtaining the best results on this level, as the grade of the track at the faces was sometimes too great and the wheels of the shovel loader slipped badly. Nevertheless, we were able to load from 60 to 80 15-cu.ft. cars per 8-hr. shift. None of the operators on this machine had had previous experience and it required two to three weeks to become proficient.

The shovel loader was used on the 600-ft. level from January to May, during which time the 750-ft. level was being prepared for a system of mining based on the use of the shovel loader. The accompanying drawing shows essential features of this system, which is shrinkage stoping without the use of chutes. Openings into the stope are made at the end of turnouts spaced 22 ft. apart. Ore from the shrinkage stope is drawn through the openings to the floor level as required to keep sufficient working room above the broken ore. The opening chokes itself as soon as the angle of repose of the ore on the floor is reached. The turnouts are of sufficient length so that enough straight track can be laid to hold both the shovel loader and the car being loaded. It may be seen from the drawing that arrangement of turnouts allows the change from loaded car to empty car in a minimum length of time. It has been found that cars can be switched in 30 seconds or less. During a one-hour test, 36 of our 15-cu.ft. cars were



Black Hawk Consolidated has laid out its 750-ft. level to permit use of the proposed mining method illustrated here based on use of the shovel loader

loaded, and our experience to date indicates that we can count on loading 150 cars per shift in regular operation.

At this property we have found the installation and maintenance of timbered chutes in connection with shrinkage stopes to be an item of major expense, and believe that the use of the shovel loader will not only be less expensive but will give greater production. We have found that cars can be loaded in less time on the average by the shovel loader than from the chutes. In using chutes much trouble was experienced with choking by boulders which had to be blasted, causing damage to chutes and considerable lost time. With the new system large boulders are thrown to one side and blasted at the end of the shift. No choking has been caused by such boulders, but we have had difficulty due to broken ore packing and running out only in channels or pipes. Blasting has been used to loosen the packed ore and start it running freely again.

We have not had sufficient time to obtain figures as to the difference of cost between handling ore from the chutes and by the shovel loader, but such experience as we have had to date indicates a material saving will be made by the new system of mining.

London Company, at Alma, Finds Loader Effective in Development

Cost of mucking in headings has been reduced 35 per cent under that of manual work

H. L. Tedrow
General Superintendent
London Mines & Milling Co.
Alma, Colo.

THE OPERATION of the London Mines & Milling Company, at Alma, Colo., consists of mining 200 tons per day from narrow veins averaging 1½ to 2 ft. in width and badly faulted. Our active schedule normally requires that a total length of 1,500 to 2,000 ft. on the veins be available for stoping. Such conditions require that operations extend over a large area both vertically and longitudinally. Development work is so widely spread that it is seldom that two headings are close enough so that a loader can be shifted from one heading to another. Unfortunately, our main shaft is so small that dismantling of a loader is required to move it from one level to another. Under such conditions it has been questionable to me whether an underground loader was economical for development work, and it is not adaptable to our mining methods. We do, however, have one Gardner-Denver underground loader which we have used successfully in drifts and crosscuts on our main levels where considerable distances have been driven on line or with easy curves. I prefer the air-operated type at this particular mine, as compressed air is always available.

At present we are driving two crosscuts using the loader mentioned in the foregoing. These crosscuts are approximately 7x8 ft. in cross-section and close enough together so that the loader can be shifted easily from one heading to the other. In one crosscut we are using two shifts of three men each and in the other one shift of three men. Each shift consists of two miners and one helper. In the crosscut where we are double-shifting each shift mucks out a round consisting of 30 to 40 tons in approximately two hours, extends the track to the face, and drills out a round, using two machines, and shoots at the end of the shift. We average 6 to 7½ ft. of advance per shift. In the other crosscut the cycle is reversed; the men drill out their rounds with two machines in the morning, blast at noon, and then muck out the round in the afternoon while the shift in the other crosscut is drilling. The same advance per shift is made. Satisfactory advance has been made in smaller-sized heading with two men on a shift. They operate the loader, tram the loaded cars to a chute, and, using two machines, blast by the end of the shift.

In our operations, inasmuch as the amount of development work done with the underground loader is small compared with the total amount of work required, there has been little actual effect on mine production. However, such work as we have done with the loader has been faster and cheaper than by hand mucking. From our experience I estimate that the cost of our development work using mechanical mucking has been 35 per cent below the cost by hand loading; and the men, on contract, have averaged approximately 20 per cent more in wages than they would have by hand loading. Our maintenance cost of the loader has been practically nothing on 3,000 ft. of crosscuts and drifts.

Most of our work here is at an elevation of 12,000 ft., with a serious reduction in labor efficiency, and from this standpoint it might be advisable to use more loaders.

I. M. Marshall, manager, Naybob Gold Mines, Ltd., Timmins, Ont., writes that one Eimco-Finlay loader is in use. It was bought to facilitate handling ore from stope preparation. After opening up a shoot by drifting, two lifts are blasted down on to the track and mucked. The loader also mucks ore from small bodies reaching not more than 40 ft. above the level, which ore is blasted down without installing timber. It likewise serves in mucking out distant headings, and also in wide headings.

Cornucopia Gold Holds Maintenance Low on Its Mucking Machine

The total cost for repairs and upkeep has been only $39 for seventeen months of service

A. V. Quine
General Superintendent
Cornucopia Gold Mines
Cornucopia, Ore.

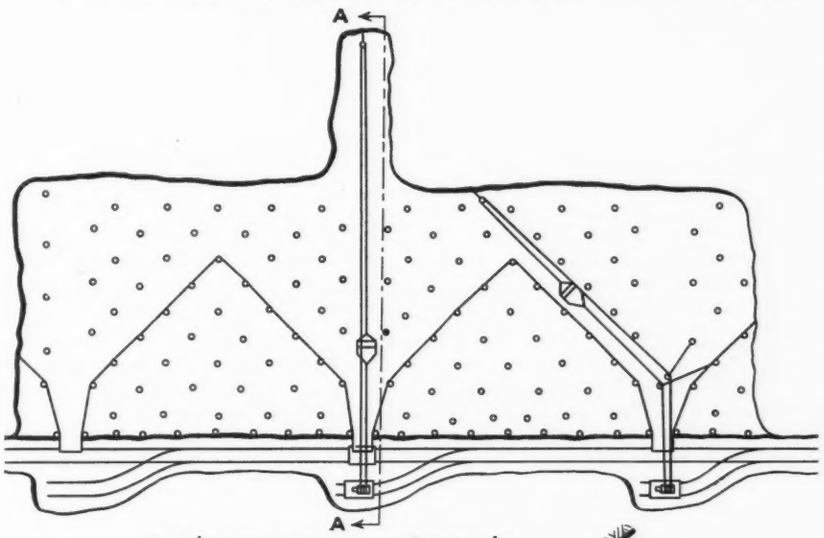
THE DAILY OUTPUT of the plant of Cornucopia Gold Mines, at Cornucopia, Ore., is around 150 tons through the mill. We have had one Gardner-Denver No. 9L mucking machine in service for about seventeen months. It has been used only in driving the main heading drifts and is certainly advantageous for this particular use. Where hand labor (two muckers) was able to muck out only a 4-ft. round in a full shift, the mechanical mucker, with the same number of workmen, was able to muck out and clean up in two hours or less a 5 to 5½-ft. round, leaving the mucking crew free to work on the transportation and extraction problems presented in our particular workings. This mucking machine, for the full time of operation, has only cost us $39 to date for maintenance. The comparative costs are easy to see, although no detail records were kept. As to its effect on employment, it would have been necessary to employ at least one man, and possibly two men, to get the same amount of work done.

We are also in the process of testing out the advantages of scrapers in our vein system, which averages 3 to 4 ft. in width, with a dip of around 38 deg. This is entirely too small an angle for muck to run by gravity and requires considerable hand shoveling to get it to the transportation cars. We have, therefore, recently purchased two small Ingersoll-Rand double-drum slusher hoists, weighing approximately 250 lb., in conjunction with scrapers of about the same weight. We are using these in our stopes, a sketch plan of which is presented herewith.

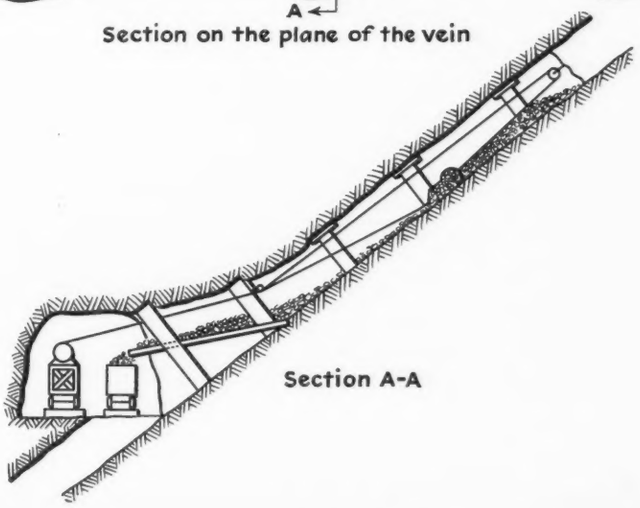
Regarding work in this latter respect, it is too early to give any cost figures, although we have calculated that such a procedure should cut our mining costs around a dollar a ton. This is somewhat problematical, however, and should not be taken as actual fact.

As to whether electrical- or air-operated machines are more to be desired, I would say that the electrical types are more advantageous where facilities are available and the mine workings are not too extensive, for they are cheaper to operate. In our particular instance we have found that the installation and upkeep of power cable in isolated workings would offset any advantage of using the electrical machines. Consequently our machines are air operated.

Cornucopia Gold is making tests to determine the advantages of using scrapers in veins 3 to 4 ft. wide and dipping 38 deg. The drawing shows one type of set-up



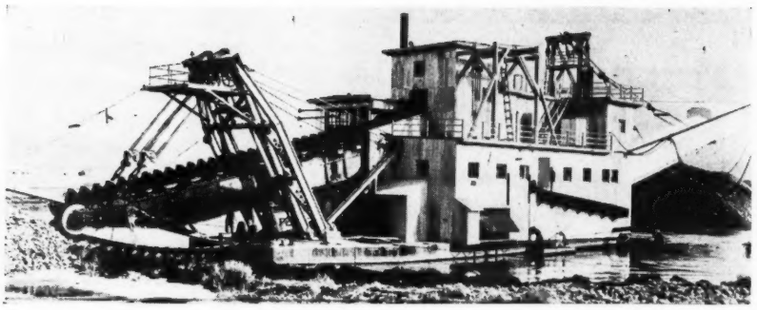
Section on the plane of the vein



Section A-A

G. L. Johnson, general manager, Indian Valley Mining Company, Inc., Greenville, Calif., reports production of about 225 tons per day. Two Eimco-Finlay loaders are in use, one No. 12 loading about 125 tons in two shifts and one No. 11 loading 30 tons in one shift. The remainder of the daily tonnage is drawn from stopes. The cost of mechanical loading is estimated to be about one-fourth that of hand loading. Maintenance cost is about 25c. per shift.

George S. Barnett, general superintendent, Alabama - California Gold Mines Company, Auburn, Calif., has two underground loaders—one Gardner-Denver and one Eimco-Finlay—in daily use. Daily tonnage milled is about 230. Each loading machine mucks one or two rounds per day from 5x7-ft. headings, and makes possible more rapid progress than with hand loading. In the long run each machine probably does work that otherwise would require the labor of two additional men. No definite figures are available on the cost of mechanical vs. hand loading. Maintenance cost of the loaders is approximately 15 to 20 per cent annually of the original cost.



The 6-cu. ft. dredge of Porter Bros. Corporation operates a placer property at Helena, Mont., partly within the city limits

Running a 6-Cu. Ft. Dredge at Helena, Montana

Operating cost over 4½ years is $0.491 per cu. yd. on gravel averaging 32 ft. in depth. Availability of natural gas has permitted work during three winters

David M. Mann

Engineer
Porter Bros. Corporation
Helena, Mont.

ABOUT A MILE north of the city of Helena, Mont., at the lower end of Last Chance Gulch, the 6-cu.ft. Yuba dredge of Porter Bros. Corporation is at work. It was here that gold was discovered in July, 1864. The old-timers first sought to recover the metal by ground sluicing, and later the Chinese became the chief operators.

The boat is a typical Yuba ladder-type dredge with a sectionalized steel hull composed of pontoon units. The enterprise is unique in that it is partly within the city limits of Helena. In consequence, electric power, telephone service, city water, and natural gas are available. The latter is used for heating the dredge during the winter months, being taken on the boat by means of a hose and distributed to thermostatically controlled unit heaters installed at strategic points. With temperatures dropping to 30 deg. F. below zero during the winter, the importance of this feature is apparent. Availability of natural gas has made it possible to operate the dredge continuously through three winters out of five. A standard working crew is employed, and most of the repair work is done at the company's machine shop. The dredge has operated 84 per cent of the time, including holidays and shutdowns due to severe weather, the daily yardage averaging 5,700. This operating percentage excludes stepping ahead, which in some instances is regarded as a function of the dredge and should be included in the operating efficiency. Our method of calculation is to deduct for this phase in the dredging cycle. Average depth of the gravel is 32 ft., varying from 18 ft. to a maximum of 60 ft. Operating cost for a period of 4½ years has been $0.0491 per cubic yard. The accompanying table breaks this figure down.

The item for water requires further explanation. The dredge is not situated on a running stream, and as a consequence water must be pumped from wells about 1½ miles distant. Some water is obtained from the overflow of the city storm drains. The average operating cost per cubic yard mentioned includes the cost of additional men and low yardage during severe winter weather, which increases operating costs considerably.

The bucket line is made up of 84 "Columbia" buckets with "Little Lips" riveted in place by six rivets to each bucket. About 15 hr. is required to re-lip the entire bucket line. By using No. 6 cutting tips on the oxygen welding unit, it has been found that cutting of old rivets can be speeded up materially and oxygen consumption reduced. Re-lipping has been done at about nine-month intervals since the dredge started operation. The ladder rollers are now beginning to wear out and to avoid buying new ones, the old rollers are first being turned down in a lathe, and then fitted with a shrunk-on ¾-in. steel sleeve welded at the ends. Though these rollers have not been completely tested, results attained so far have been satisfactory.

On the lower tumbler, which operates under water a greater part of the time, a cast-iron seal bearing made by the Columbia Steel Casting Company has proved beneficial. The bow line cables require the most frequent replacement. The ladder hoist cables must, of course, be kept in the very best condition at all times, and consequently are never left on the ladder hoist until they are worn out.

Use is made of the partly worn hoist cable for bow lines, and it has been found that the old hoist cables stand up as well as the new cables—oftentimes longer. For the hoist lines Roebling and Leschen ⅞-in. I.W.R.C. cables are used, their life varying six to eight months. When subsequently used as bow lines another three to six months' use is obtained. Originally, ¾-in. cable was used on the spud lines, but because of frequent breakage, necessary alterations were made on the drum and sheaves to permit the use of ⅞-in. cable. This change has made possible use of old bow lines as spud lines, which, as known, are considerably shorter than the bow lines. Since making this change little or no trouble has been had with the spud line.

The revolving screen is 30 ft. long and 6 ft. in diameter. It is covered with one upper section containing holes from ¼ in. to ⅜ in., and four lower sections with holes ranging from ⅜ in. to ½ in. Average life of a section is about ten months, with one unit being changed at a time as they wear out. This work is done on clean-up days, when a double crew is employed on day shift, and but little time is lost changing the screen. The gold recovery area on the dredge consists of about 1,400 sq.ft. of riffles, of which nearly half constitutes the primary tables running at right angles to the axis of the dredge, and the remainder the secondaries installed parallel to the axis of the dredge.

Since operation was begun, in 1935, a record of the percentage of each clean-up recovered from the secondaries has been kept, the figure being less than 2 per cent, with many clean-ups averaging less than 1 per cent. This demonstrates the adequacy of the tables installed on the dredge.

The stacker is covered with a canvas housing, which is about ready to be replaced. The conveyor belt is made by the American Rubber Company and is 30 in. wide. It has been replaced approximately every two years.

Four-Year Operating Cost

Operating expenses	Cost Per Cu.Yd.
Heating	$0.0008
Insurance	0.0018
Labor	0.0199
Oils and greases	0.0008
Power	0.0069
Repairs	0.0099
Shop	
Labor	0.0018
Materials	0.0005
Power	0.0001
Insurance	0.0001
Supplies	0.0017
Truck expense	0.0007
Water	0.0011
Testing	0.0019
Sundries	0.0011
	$0.0491

Hydraulicking for Gold at Poverty Hill

Contract stripping replaces former practice of mining entire bank—Washing 75,000-100,000 cu.yd. per month. Tailings are stored and water is recovered

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POVERTY HILL MINE is situated in the west end of Sierra County, Calif., at an elevation of 4,000 ft. The winters are generally severe, with heavy snowfalls and freezing temperatures. A good paved road serves the mine, running 45 miles from Marysville to Browns Valley, where it connects with Strawberry Valley, with 12 miles of dirt road leading past Scales to the Poverty Hill mine. Only during continued wet or snowy weather are the roads impassable.

Poverty Hill channel is that part of the Laporte Tertiary channel as described by Waldemar Lindgren[1] between Slate Creek and the junction of the Portwine channel above Scales. The grade of the channel averages 2 per cent to the south. The deposit is characterized by a uniformly fine wash consisting essentially of quartz and medium-sized particles, generally under 6 in. in diameter.

The deposit is well stratified, but loosely consolidated, and during wet weather steep banks slough readily. The percentage of rocks over 6 in. in diameter is negligible. Clay occurs in thin beds within the overburden and hence offers no obstacle to gold recovery.

Gold was discovered in the placer deposits at Laporte and at Poverty Hill in 1850, at approximately the same time. Mining claims were laid out in 100-ft. squares and were operated as independent hydraulic mines. At Poverty Hill there were several such operations. The Sawyer decision of 1884 put an end to hydraulic operations. Poverty Hill was one of the original thirteen mines enjoined. Several efforts were made to exploit the deposit by other means. The property was investigated by Janin, Smith, and Stebbins, during the 90's, as a drift-mining possibility. Their findings were negative. A previous attempt to mine a portion of the channel by drifting during the 60's had failed. Later the property was drilled for possible dredging. Erratic recoveries from the holes, and the great overburden, stopped this effort.

With the increase in the price of gold in 1933, interest revived. A plant was installed in 1935, at a point 2,000 ft. south of the face left by operations in 1884. This has been referred to as the South pit. With limited water available, the plan called for mining by tractors and 8-cu.yd. carryalls delivering to a conveyor. The plan proved unsuccessful, due largely to excessive wear on tractor tracks and inability to uncover the pay channel with the money available. It was impossible to drain the pit completely, due to adverse grade, and as the deposit was largely quartz and gravel, the tractor operated in the pulp of this sand, gravel, and water. Tracks had to be replaced after each 72 hours of operation.

At this time the present owners became interested and in 1936 assumed full control. The summer of 1937 was spent in sampling and testing. Samples were taken from cuts across the overburden and test pits to bedrock were sunk. Sampling in the North pit indicated recoverable values of 35c. per cubic yard from bedrock to top of bank, with only about 5c. of this in the overburden. In the South pit

1 "The Tertiary Gravels of the Sierra Nevada of California," by Waldemar Lindgren, U.S.G.S. Professional Paper 73, 1911.

At the Poverty Hill mine—a general view from the bottom of the bank. In the foreground is the sump and pump delivering to the washing plant, which is further away at the right. In the background is the tailings dam. The tailings line and return water line can be seen

sampling indicated recoverable values of 25c. per cubic yard, with approximately the same content in the overburden. The lower values in the South pit were ascribed to the greater overburden and there was question as to the location of the center of the channel. However, recoverable values were sufficient to justify large-scale work.

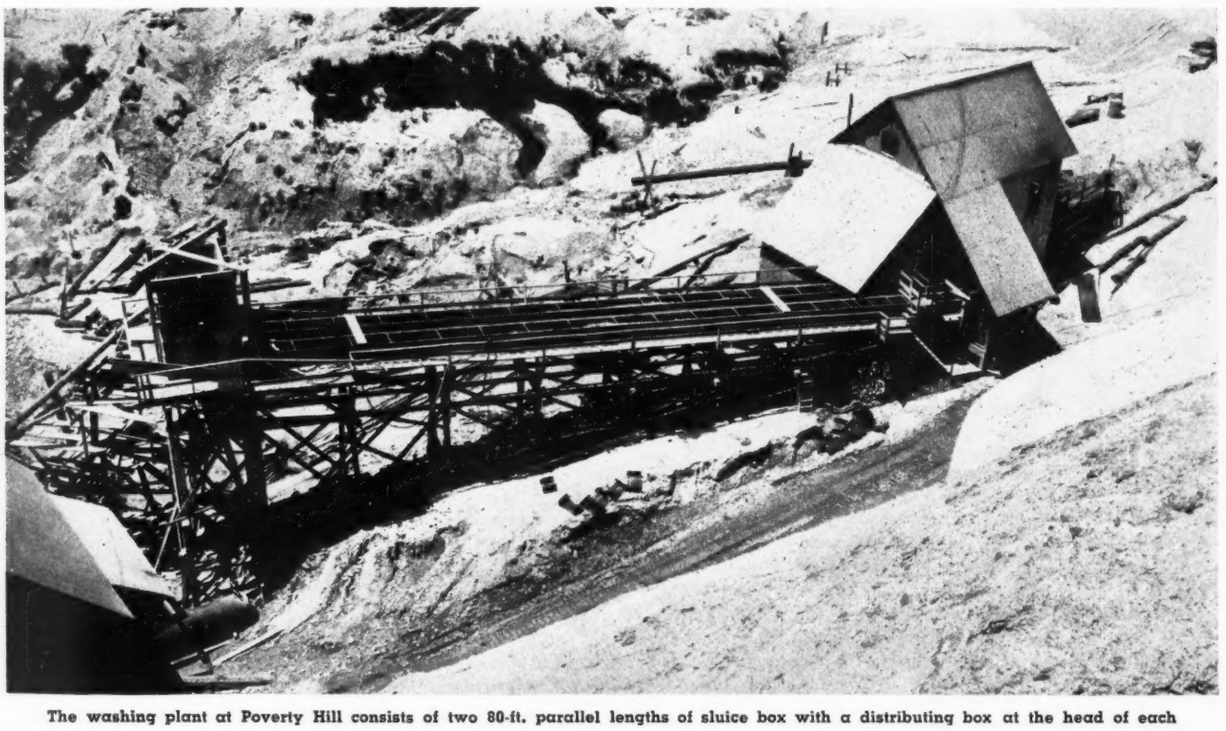
The owners conceived the possibility of an operation based on hydraulic mining and subsequent pumping of the gravels through a washing plant to tailings. A screen analysis disclosed that 55 per cent of the bank passed ⅜-in. opening. A small pilot plant was designed and operated during 1938. It consisted of a Caterpillar D-13000 power unit, driving through a jack-shaft both a 10-in. Byron-Jackson dredge pump and a 4-in. Byron-Jackson rain pump. Pressure from the latter provided sealing water for the gravel pump as well as pressure for a No. 0 Hendy giant with a 1-in. nozzle. Volume of water for mining was approximately 400 g.p.m., and nozzle pressure approximately 40 lb. It seems inconceivable that so small a stream could effectively attack such a bank, but actually it was able to cave the bank as rapidly as the pump could deliver the gravel to the washer. The equipment was set up on a barge built of six cylindrical tanks of 1,400-gal. displacement each. Engines and pumps were mounted on the deck and a winch was used to raise and lower the gravel-pump suction. Winches with ⅜-in. guide cables were used to hold the barge in position. The routine was to mine tops, and, while doing so, to float the barge in about 20 ft. of water. After sufficient tops were mined, the pit was pumped dry and the barge set on bedrock, and with a small sump the bottom gravels were pumped. Whatever large rocks were present were along bedrock and could be sorted out while cleaning the bottom material. A Caterpillar 50 tractor with a bulldozer blade was used to clean bedrock as well as to help in tailings disposal. The gravel distintegrated readily and the beating action of the pump vanes helped separate the particles. The gravel was pumped over a dam to 80 ft. of sluice box set on a grade of ¾ in. per foot. Riffles were made in removable sections, using 1½x1½x⅜-in. angle iron. Sections consisted of six angles, welded to 8x18-in. side plates. The sluice boxes were steel boxes 24 in. by 10 ft. long by 15 in. deep. Each box section was bolted and lapped to the next one. Careful investigation of the tailings showed that unseparated particles were rare. The fine sands and slimes settled readily, so that a clear return flow could be maintained.

As the tested area was small, it was decided to install a plant with minimum capital expenditure. Late in 1938, plans were being drawn for large-scale work and the owners wanted careful consideration of every possible means of attack. Operation of the pilot plant disclosed the possibility of a large-scale operation based on hydraulic mining, and subsequent pumping. However, other possibilities were reviewed. Hydraulic monitors and elevators were considered, but the investment necessary to provide sufficient water was too great and the period of operation each year was too short to yield adequate returns. Since the area drained into the Bullard's Bar Dam storage basin of the Pacific Gas & Electric Company, a 2c. storage charge per cubic yard by that company added to the direct expense. Hydraulic mining and dredging were considered, but here again capital requirement were deemed too great without a large preliminary outlay for sampling and testing. The money required would cover a good part of the cost of installing a plant.

A dragline operation was weighed, but the equipment to handle a bank 100 ft. deep successfully also meant a considerable capital expenditure. At the same time, it would be necessary to provide a complicated washing plant and an adequate return flow, as well as tailings disposal. This method would prove nearly as costly as dredging and would show higher operating costs and an inability to clean bedrock properly.

Stripping the overburden and either pumping the bottom gravels or mining with dragline, carryalls, or shovels was considered, but was finally decided against, as it was felt the indicated 5c. recoverable values would justify mining the whole bank. The previous experience, with excessive tractor wear, made this mechanical mining seem hazardous.

Decision was finally made to mine the whole bank on an all-pumping and hydraulic mining procedure with operations based on an eight months'



The washing plant at Poverty Hill consists of two 80-ft. parallel lengths of sluice box with a distributing box at the head of each

A close-up view of the tailings dam. The tailings discharge and return flowpipe can be seen. In the background is the water supply

program. The bank was to be mined in one operation by caving it by undercutting along the bedrock, and washing the gravel to the pumps. The final plant was to be built around the equipment then available. During the winter of 1938-39, plans were prepared for installing the necessary plant.

Equipment needed for hydraulic mining was based on an output of 100 cu.yd. per hour. Volume of water necessary was estimated at between 2,000 and 2,500 g.p.m. at 70- to 90-lb. pressure. A National Supply Company 1D-8 Superior diesel engine was provided to drive a Fairbanks-Morse single-stage, 10-in. suction and 8-in. discharge pump through V-belts. A new return-flow pipe was laid. This was 15 in. in diameter with slip-joint construction. The pump discharge was through a 12-in. line to a Y, and then through two 10-in. lines to two No. 1 Hendy giants set on either side of the pit. Plans called for use of either one or both giants, and nozzles from 1½ in. to 3 in. were provided to supply whatever volume or pressure of water might be found necessary to perform the task.

To provide adequate disposal of tailings and to overcome the adverse grade of the bedrock, gravels were to be pumped in two stages. The area originally mined exposed 2,000 ft. of channel to a width of 600 ft. This was to serve for storing tailings and to provide storage for the water supply. In the first stage, the gravel was pumped from a sump through a washing plant, and in the second, from the plant to tailings disposal. Both pumps were 6-in. D-Frame Hydroseal gravel pumps, with 26¾-in. diameter impellers. The primary pump was installed on the reconstructed original barge. Revision included substituting three of the cylindrical tanks with a large rectangular steel tank of somewhat greater displacement. The pump was set in the bottom of this rectangular tank so that the center of its suction was as close to bedrock as possible, and with the pump driven by a diesel engine that was a duplicate of the one driving the mining pump. This was set to drive the pump through V-belts, with the driving pulley vertically over the driven pulley. Pump speed was 540 r.p.m. Space was conserved, and greater pump efficiency resulted by the lower suction obtained. A 15-ft. suction pipe was raised and lowered by cable and pulleys were operated through a worm gear. Jets were added to regulate flow and density of the pulp. To maintain proper velocities in the discharge lines, and to prevent clogging, 9-in. discharge pipes were used. These were obtained in 20-ft. lengths, which were connected by standard Dayton couplings.

The tailings pump was so set that it could be driven either by the Atlas engine that was available or by the Caterpillar D-13000 power unit used on the pilot operations. Power requirements at this point were less than at any other section. Since this equipment had been previously used, power failures were thought more likely to occur at this installation than at any other point. The engines were therefore so set that by a jack-shaft one or both would drive the Hydroseal pump. Drives were connected through V-belts. Pump speed required was 500 r.p.m. Tailings from the sluice boxes were discharged into a box feeding the tailings pump, so that this worked under flooded suction. The discharge line was 9 in.

The washing plant consisted of two 80-ft. parallel lengths of sluice box. Sufficient steel boxes were on hand to provide the necessary sluices. Grade was ¾ in. per foot, and additional removable riffles were added. Wear on previous sections resulted in substituting ¼-in. for ⅜-in. angles. The two lengths of box were provided, so that during clean-up the gravel stream could be diverted from the box being cleaned. Mercury was added to the sluice boxes. When these are cleaned the amalgam is separated, and a concentrate saved and ground in an amalgam barrel. The amalgam is added to the rest, and the whole is retorted. The gold averages 935 fine, and sponge as shipped averages $30 per ounce.

Installation of the plant was completed by the end of June, 1939. Serious mechanical troubles with one of the new engines caused delay. Two difficulties early developed. One was the inability to maintain an even flow to the primary pump, thereby causing surges, and the other was excessive pump wear. The first was corrected by enlarging the sump at the primary pump, providing a grizzly to remove oversize, and adding an elec-

tric hoist and slusher to aid the monitors in feeding the pump. The giants could cut the banks faster than the pumps could remove the gravel, but as the distance from the pump to the bank increased, greater difficulty developed in bringing the gravel to the sump. Also, the 100-ft. height of bank forbade keeping the pump as close to the bank as efficiency would dictate. After sufficient area was opened the inability to feed the pump properly was disclosed and the slusher was installed. The D-13000 unit was used to drive a 75-kw. a.c. generator, which supplied 440-volt current for the Sullivan three-drum 35-hp. hoist, that ran the scraper. Thus it was possible to keep a steadier flow of gravel to the pump at a higher pulp density.

With increased pump output, the wear on pump parts became greater. The abrasive effect of this quartz was beyond expectation and the manufacturer was unable to supply pump materials to reduce it. Late in 1939, Nihard was found to offer greater abrasion resistance than manganese steel and was substituted for other pump parts, and though the resistance to abrasion has not been as great as anticipated, it none the less has decreased pump replacement cost from 8c. per cubic yard to an indicated cost of 6c.

Original pipe lines were made of special high-carbon steel. Present practice dictates use of standard 9-in. pipe with plain ends. Replacement costs amount to 1c. per cubic yard. Due to the high velocity of gravel through the lines, plus the abrasive effect, lines are good for a maximum of 100,000 cu.yd. before being discarded. Pipes are turned three times. The primary suction pipe is made of Nihard sections, with 1½-in. side walls, connected by a section of 10-in. eight-ply dredge hose, which permits the bending necessary.

Although engine trouble at the start caused delay, at present, with well-organized crews, regular inspections, and generally better mechanical supervision, the loss of time caused by mechanical troubles has been greatly reduced.

Operations during 1939 were stopped after Christmas, when winter storms commenced, and consideration was given to possible changes for the 1940 season. It had been discovered that the overburden contained not over 1c. per cubic yard instead of the 5c. indicated by the original sampling. So it was decided to strip as much as possible of the overburden and pump only the pay streak of the 100-ft. bank. The 1939 work had shown that little values occurred in the gravel from a point 25 ft. above bedrock to surface. Plans were made to strip as near to that point as possible. For the 1940 season static head on the primary pumps was greater due to the increased length of the discharge lines running to the washing plant. Static head on the tailings pump increased due to the raising of the point of tailings discharge.

To provide greater power the pumping units were changed. The Superior diesel engine previously on the mining pump was placed on the tailing pump and the Atlas diesel was set to drive the mining pump. All the engines were completely overhauled. The increase of static head from 80 to 95 ft. resulted in the need for greater power on the gravel pumping. Power requirements on each pump are 105 hp.

The recovery system was changed to include a distributing box at the head of both sluice boxes. The grade of the sluices was raised to 1 in. per foot. Pulp density was increased to an average of 15 per cent from less than 10 per cent. Greater yardage output and recovery have resulted.

The mining pump is driven at 1,680 r.p.m. furnishing 2,000 g.p.m. at 75-lb. pressure. This, in addition to providing monitor water, provides sealing water for both pumps and water for the jets on the primary pump suction. Power requirements in this part of the operation are 85 hp. Duty per miner's inch of water is 10 cu.yd. per 24 hours.

Bids were called for stripping. Specifications included mining an area 350 ft. wide, with side slopes 1:1, and to as great a depth as found economical. It was planned to mine to maximum depth as close to the bank as possible to benefit the mining operations immediately. Fortunately, the channel's topography was such that just ahead of present operations, the surface sloped to a lower relief. The stripping contract was let to J. N. Tedford, of Fallon, Nev. A prolonged wet spring delayed the start of work until after May 15 and there was further delay because of slow delivery of equipment. By the end of June stripping was progressing at the rate of 2,500 cu.yd. per day. Once a definite pit has been established, this rate will be bettered.

Two stripping units are used. Both consist of Allis-Chalmers 110-hp. tractors and 15-cu.yd. LeTourneau carryalls. The 15-yd. carryall can be loaded without scarifying, or without the use of pushers, although the use of latter expedites the loading. No difficulty is anticipated when further depth is reached, since the channel is uniform in the texture of materials contained.

Spoil is unloaded on either side of the channel, but not within 100 ft. of the pit. Adequate area is available for all that is removed. As stripping and mining are advanced, the rate of stripping will be further increased so that by October sufficient will have been done to permit mining until the season end.

Plant capacity has been increased from 30,000 cu.yd. per month to between 75,000 and 100,000 cu.yd., with only 40 per cent increase in total cost. Gold recoveries will increase almost directly with the increase in output. Stripping costs are definite, being on contract. Mining costs have been determined within a close range. Pumping capacity has been made to conform with stripping operations. Wear of pump parts is still being investigated, and by the end of the season it is hoped that the high replacement cost of pump parts will be partially obviated.

The total crew consists of 33 men: three 8-hr. shifts of 5 men each, including 1 monitor operator, 1 slusher operator, 1 tractor operator, 2 diesel operators; three 8-hr. stripping shifts of 3 men, including 2 tractor-carryall operators and one oiler; one 8-hr. shift, including 1 blacksmith; 1 welder; master mechanic; swing foreman; general superintendent; and cookhouse crew of three. The latter unit is self-supporting. Labor duty is 80 cu.yd. per man-day.

Largest among the supply cost items are diesel oil and pump replacement costs. The fuel oil consumption averages 700 gal. per day with approximately the breakdown given in the table at the foot of this page.

The chief item of pump wear is pump shells. Manganese factory pump shells last between 525 and 600 hr. Nihard shells last from 600 to 700 hr. Factory impellers last from 250 to 300 hr. Nihard impellers last from 400 to 450 hr. Nihard suction sleeves outlast factory suction sleeves 2:1 and Nihard pipe sections outlast standard high-carbon steel pipe sections from 3:1 to 5:1. While the use of Nihard for pump parts has not been entirely satisfactory its use has resulted in a 25 per cent reduction in replacement costs.

Army Adams is superintendent of operation at Poverty Hill. The success of the enterprise is due to his ability and untiring efforts and the cooperation of an efficient crew.

Diesel Engine Fuel Oil Consumption

Engine	Purpose	Gal. Per Day Diesel Fuel Oil
Superior ID-8	Primary gravel pump	140
Superior	Tailings pump	135
Atlas Imperial	Monitor pump	95
Caterpillar	Electric generator	50
Cat "50" tractor	General utility	80
Allis-Chalmers	Stripping	200
Total		700

Designing the Small Mill

An important matter, though one that is often slighted. Careful planning of construction and equipment is needful, irrespective of capacity

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MILLS of the smaller size, of a daily capacity of say not more than 300 tons, such as I shall deal with in this article, require to be properly designed fully as much as do the larger ones. Once reliable test results are available, the problem of designing becomes a matter of the experience of the designers. In this discussion I shall limit myself to flotation and cyanide plants treating gold, silver, copper, lead, and zinc ores or some combination of them.

Three essentials to keep in mind from the outset are (1) simplicity, (2) smoothness of operation, and (3) selection of the proper types and sizes of equipment, to avoid "bottlenecks" in the flowsheet. The plant should be designed completely as early as possible before construction is begun. Only thus can pitfalls be avoided.

Proper selection of the mill site depends on many factors. The most important of these are that the mill, when built, shall be near the natural point for delivering ore from the mine; that it shall be as close as possible to the water supply; that a suitable place for disposing of tailings be available and that the slope of the mill site shall be such as to fit the flowsheet.

The flowsheet itself naturally should be that which best fits the ores of the particular property, so as to give the highest possible economic returns from the assured ore reserves. In the case of precious-metal ores there is the problem of selecting a flotation flowsheet as against one for a cyanide plant. Only by careful study of the conditions and the test work can decision be made as to which of the two kinds of plant is the one to build. A cyanide plant will cost more to erect, but will generally give higher economic returns per ton of ore treated.

Flotation plants—For flotation plants of the range of size here considered we have found that a simple crushing plant is best. For plants up to 150 tons' daily capacity, a single-jaw crusher of a type capable of making a $\frac{5}{8}$-in. to $\frac{3}{4}$-in. product and preceded by a grizzly or screen is preferable. With it one man can take care of the crushing easily in one shift. In plants of 150 to 300 tons' capacity a secondary cone-type crusher should follow the primary unit and the cone crusher itself should always be preceded by an efficient vibrating screen to remove fines from its feed. On mills of the sizes covered it is seldom economical to "close-circuit" the secondary crushing plant. Tramp iron protection is very desirable. Belt conveyors should not be run at too high speeds. They

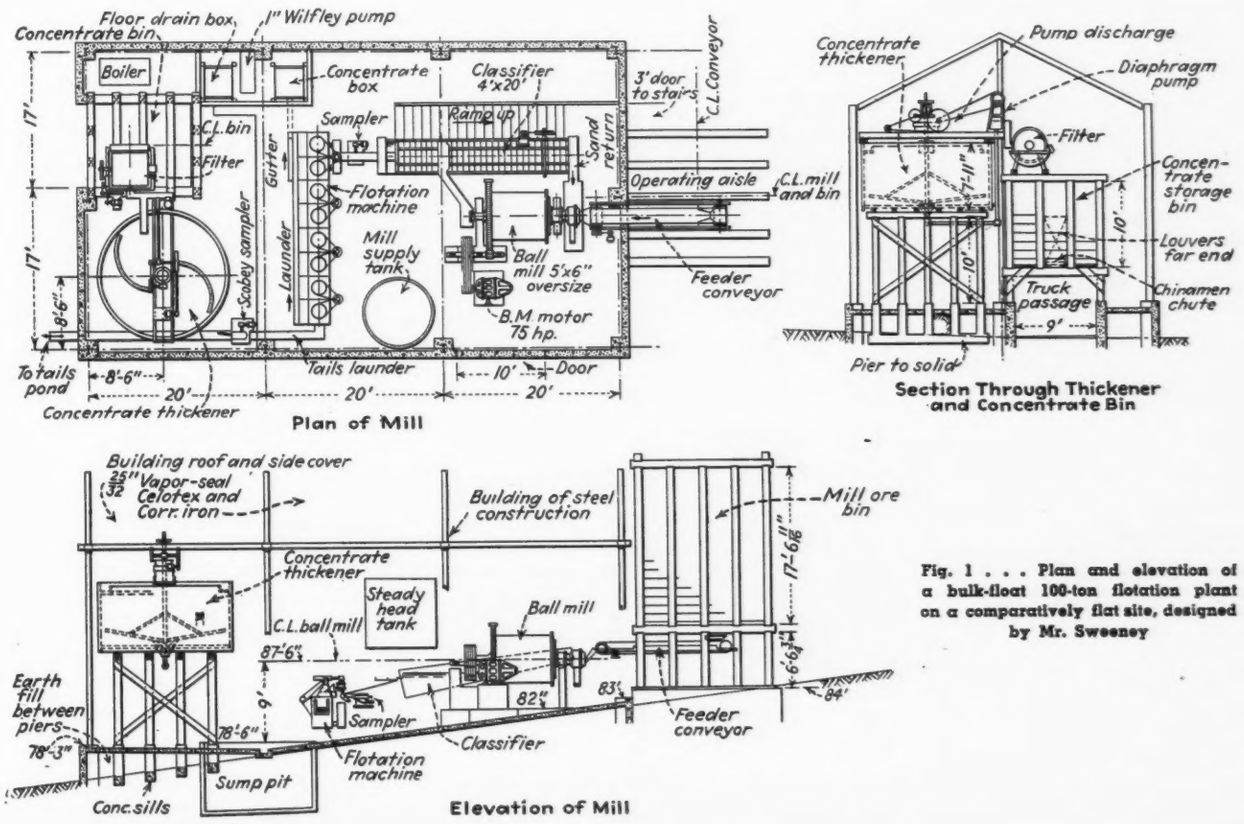

Fig. 1 . . . Plan and elevation of a bulk-float 100-ton flotation plant on a comparatively flat site, designed by Mr. Sweeney

should have remote-control stop buttons to save damage to conveyors.

Storage both before and following the crushing plant is an important matter. We prefer to keep the tonnage of the coarse ore bins to approximately the capacity of the plant itself. Storage of uncrushed ore in larger tonnages than this is expensive and also requires expensive equipment to get the ore moving again. For crushed-ore bins the more storage capacity provided the better, as this relieves the mill from ore shortages due to either non-delivery by the mine or to crushing-plant troubles, thus insuring continuous operation. It is very hard to sell to property owners the idea of large storage capacity in the crushed-ore bins, but, as stated, the larger capacity will be found to be of great value.

The grinding circuit is the heart of any mill, and therefore the selection of the grinding unit or units and the classifiers should be made most carefully. A reliable type of feeder for the grinding circuit is necessary, so as to provide a steady rate of feed.

One of the most common errors in selecting this equipment is to have the grinding units and the classifiers out of balance. In the smaller plants here dealt with, we prefer a ball mill as compared with a rod mill, due to the fact that it is much more flexible. With a new mine it is possible that the degree of grind desired may easily change over a period of years, and the ball mill is flexible enough to meet such change. On the other hand, if finer grinding is later found necessary, the rod mill may not be able to meet the changed condition. Classifiers of spiral and of rake types are practically in universal use. Many good makes are available. Here again only experience will allow the proper selection of the type and size which will best fit conditions.

With many ores, today, jigs or unit cells are included in the grinding circuit, producing a coarse concentrate which in the case of precious-metal ores is at times amalgamated. If recovery of the precious metals can be made by amalgamating, it should always be done, due to the higher price now received from the Mint and the smelters.

Concentrating tables are also included in many precious-metal grinding circuits and the table tailings are returned to the classifier. Generally when tables, jigs, or unit cells are so included a small trommel screen is attached to the ball-mill discharge, and the undersize of this screen only is delivered to this concentrating equipment.

Many efficient types of flotation machines are available. The points to keep in mind in making a selection are (1) flexibility, so that cleaning and re-cleaning as desired may be easily done; (2) ease of changing the water level in individual cells; and (3) that the machine is capable of picking up the load after a shutdown without being dumped.

Reliable and accurate reagent feeders are essential to the proper operation of a flotation plant. Especially in the case of a differential flotation plant, it is advisable to have a central place from which all reagents may be fed to the various points in the flowsheet.

The matter of reliable samplers is often overlooked in smaller plants. If installed, they will allow the operators to arrive at a more accurate metallurgical balance.

In differential-flotation plants the selection of the various pumps and conditioners needed to give the proper time of contact and to introduce the pulps at the proper points is important.

In few operations will it pay to eliminate the concentrate thickener if a filter is to be installed. This will add so much water to the concentrates as to "drown" the filter. The use of concentrate boxes, properly designed, has been successful in the smaller-sized units, especially where the concentration ratio is high. Impacting by vibrators is a great aid when such boxes are used, and some installations have given as dry a final concentrate as a thickener and filter with lower installation and operating costs. Spare sections should always be provided.

We have found in mills where concentrates are to be handled by truck that it is best to elevate the thickener and filter, placing the latter on top of the concentrate bin, thus allowing the truck to drive underneath it and be easily loaded with a Chinaman chute.

When pumping has to be done it is best to pump the small amount of concentrates rather than the entire pulp. This also will allow returning the filter overflow and filter clean-up by means of this pump to the thickener.

Wherever possible we find it best to have the principal and concentrating equipment as near on one level as practical. This aids the operator in supervising the plant properly and leads to better metallurgical results and lower costs.

Fig. 1 shows in plan and elevation a single-product 100-ton flotation mill illustrating the points made.

Cyanide plants—The same considerations apply to a cyanide plant as to a flotation plant, so far as bins, crushing, and grinding units are concerned.

The size and number of agitators to be used are important. We have found that in practically every case a minimum of three agitators should be used to prevent any possibility of the pulp short-circuiting. Many types of agitators are available, and with practically all of the standard types we have had good success.

Washing of the pulp needs careful consideration. The three standard methods are countercurrent washing, countercurrent washing followed by filters, and the use of washing thickeners of the multi-tray type. If the climate is such that thickeners can be placed outdoors, a countercurrent washing plant would often be the cheapest to install. On the other hand, in colder climates where housing is necessary and expensive, filters are more often used for final washing. This is also the reason why washing tray thickeners have been used at several plants in recent years.

The countercurrent plant is more simple to operate. In practically all cases diaphragm pumps are used with the thickeners. The best type of clarification and precipitation equipment will be found the cheapest. Older types of zinc boxes are used in few plants today. The piping layout of a cyanide plant is important and requires operating experience on the part of the designer so as to give the best set-up to meet the varying conditions which may arise.

One of the most common pitfalls for untrained designers of mills is the purchasing of new types of equipment which are yet untried. It is far better to let the larger companies do the necessary experimenting and stay with tried and proved equipment. High-class equipment will be found to give lower operating costs over a period of time.

As to drives for various units, we have found that V-belt drives are more

Typical Mill Operating Costs from Actual Results

Costs Are per Ton of Dry Ore Milled

	Plant A 100-Ton Gold Flotation Mill. Grind 3% on 60. 20/1 Conc. Ratio. Public Service Power @ 1.25¢ per Kw.Hr.	Plant B 150-Ton Pb-Zn Float. Grind 2% on 65. 8/1 Con. Ratio. Public Service Power @ 1.22¢ per Kw.Hr.	Plant C 100-Ton Gold Cyanide Plant. Grind 2% on 60. Easy Washing. Public Service Power @ 0.097¢ Per Kw.Hr.	Plant D 100-Ton Gold-Silver Cyanide Mill Grind 2% on 80. Difficult Washing. Public Service Power @ 1.10¢ Per Kw.Hr.
Crushing cost	$0.08	$0.09	$0.08	$0.09
Steel consumption	0.12	0.17	0.12	0.16
Reagents	0.08	0.16	0.27	0.35
Labor — all	0.36	0.34	0.38	0.47
Power — all	0.25	0.39	0.28	0.38
Repairs and renewals	0.07	0.11	0.12	0.13
Tails disposal	0.03	0.02	0.03	0.07
Water	0.04	0.01	0.05	0.10
Total direct milling cost	$1.03	$1.29	$1.33	$1.75

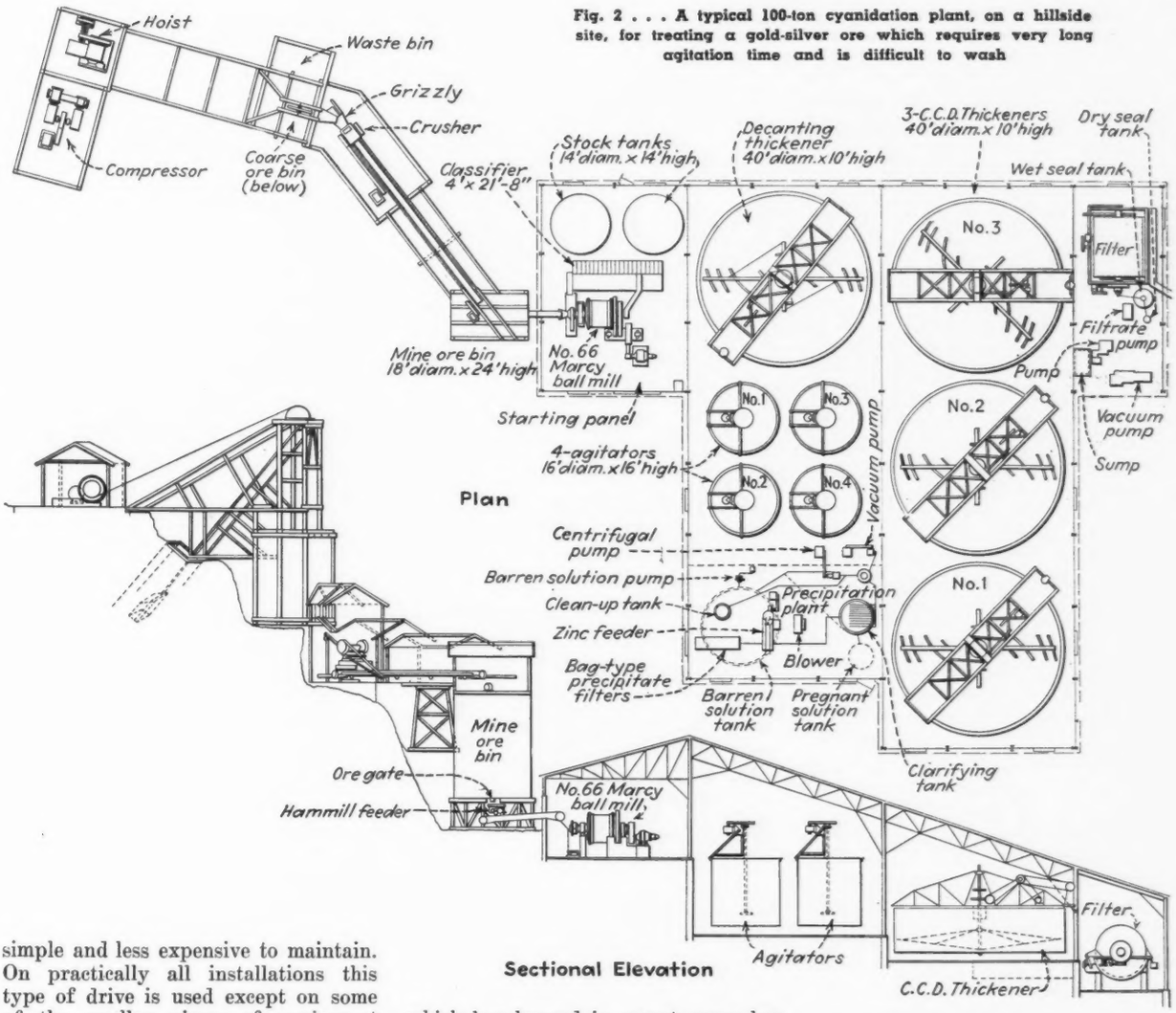

Fig. 2 . . . A typical 100-ton cyanidation plant, on a hillside site, for treating a gold-silver ore which requires very long agitation time and is difficult to wash

simple and less expensive to maintain. On practically all installations this type of drive is used except on some of the smaller pieces of equipment which are direct-connected to motors. Today a plant may be erected eliminating the old line-shaft drives and at a lesser cost.

Fig. 2 shows in plan and elevation a typical 100-ton cyanidation plant for treating a gold-silver ore which requires a very long agitation time and is difficult to wash. The best type of building depends largely on the climate. Bolted steel buildings, if properly designed, can now be erected at a cost only slightly higher than that of frame buildings. Celotex or similar material will give better insulation, in colder climates where it is needed, than the older wood sheathing. The cost of such insulation is higher, but it also gives better fire protection, and will likewise effect a saving in the cost of heating the plant. For an outer cover galvanized corrugated iron is almost universally used. Sufficient windows should be provided to give ample light. It is also essential that good artificial lighting be provided so that there are no shadows.

Wiring in such plants, both for motors and for lighting, should be in conduit, as our experience has shown that the loss of practically every mill which has burned in recent years has been caused by faulty wiring.

Where heating plants are needed we have found that low-pressure boilers with unit heaters will give the lowest first cost as well as operating cost. Concrete floors with ample slope and drains will be found a good investment in any mill. The proper working out of all launder slopes should be an important feature of the design. If there is any possibility that the plant may later be enlarged, it is better to provide extra capacity in the original plant as far as bins and crushing equipment are concerned, and often, in the case of flotation plants, in the thickeners and filters. It is hard to enlarge these sections save at excessive cost.

Many amateur builders of mills have involved their companies in grave difficulty through not having made a proper budget at the start to cover the expenditure fully. Such a budget can be made efficiently only by persons who have had real experience in mill design and erection.

Careful determination of the amount of water needed should be made. The average flotation plant without reclaiming any water from the tailings uses approximately 4½ tons of water for all purposes per ton or ore. For a 100-ton unit it will amount to approximately 75 g.p.m. Any recovery that can be made throughout the entire year from the tailings may be deducted from this figure. One should note, however, that it is difficult to recover much water from a tailings dam in the early stages of the operation of a mill. A tailings thickener placed in or near the mill, of the proper size for handling the entire mill tailings, will allow the recovery of approximately 50 per cent of the water, thus cutting in two the amount of new water needed. In this connection our experience has shown that by discharging the tailings at approximately 50 per cent solids from the thickener, they can be stored at a very low angle of repose and over a large area. This is an important point where stream pollution has to be considered.

In the operation of cyanide plants much less water is needed. For example, with a countercurrent washing plant it is practically always possible to discharge the tailings by use of diaphragm pumps at around 50 per cent solids. Thus, in a C.C.D. plant

approximately 1 ton of water per ton of ore is the average consumption, not including evaporation. For a 100-ton plant only 24 g.p.m., approximately, would be needed. This amount can be further reduced by filtering the tailings for the final wash, if the filtered tailings can then be disposed of. If the tailings are filtered and water recovery is important the tails are usually disposed of by one of several means such as dragline, conveyor, and tramway.

The matter of tailings disposal is becoming increasingly important in many places, due to legislation covering stream pollution. It is not a simple matter to design launders and tailings dams properly so as to give the best results.

Power for mills of the sizes covered here can best be purchased from the public service company if the main lines of the power company are not too far away. The rate for such power varies in various districts. On the average case it will be between 1 and 1½c. per kilowatt-hour used.

If a power plant has to be installed to operate the mill, a good make of diesel engine will give the cheapest power, after all factors are considered. The diesels should have direct-connected generator and exciter, proper cooling-water facilities, and competent operators. There are many makes on the market for such service, but the better types will be found to give cheaper and more continuous service.

Dust collection is a matter generally neglected in smaller mills. However, it should at least be given consideration in the design of a plant, inasmuch as future legislation may compel the installation of equipment for this purpose.

Operating costs of such plants will vary over a wide range, depending on the type of plant, hardness of ore, grind required, concentration ratio in the case of flotation plants, amount of agitation and washing required in the case of cyanidation plant, cost of power, and the efficiency of the operators.

The accompanying table on page 70 shows costs of four typical plants which we have erected in recent years.

Once the decision has been reached to erect a plant, a good mill superintendent and crew should be selected. We have observed many cases where the hiring of a better trained crew, at slightly higher daily costs, has greatly increased the economic return of the mill. A simple mill log sheet should always be kept. This should show all the essential mill operation data, and will be found a great aid. The time needed for building such a plant varies and will depend chiefly on the delivery time of equipment and the skill and experience of erectors. It will vary according to the size of plant also, but should not be less than two or more than four months.

Some Milling Hazards

Difficulties of small enterprises are often rooted in conditions existing before construction was begun

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INASMUCH as most of the problems and difficulties encountered in operating a small mill, which is so often the initial plant of a developing mine, were foreordained before its construction was begun, it is much more important to obviate future problems before the plant is constructed than to attempt to correct them after it is in operation. The manager engineer or metallurgist who accepts the responsibility for deciding on the construction of the initial mill would do well to consider the factors which if not given intelligent study may lead to disappointment and failure, and even ruin what otherwise might have been a successful mining venture, to say nothing of his professional reputation. This is evidenced by the large number of small milling plants, many of which have been perfectly engineered from a construction and metallurgical viewpoint, that have been complete economic failures, while others have failed from mechanical or metallurgical reasons, or both. In almost all cases, the causes could have been avoided.

The principal pitfalls are, in order of importance, as follows:

1. Lack of sufficient ore developed to warrant construction of a mill. This is by far the most important factor to be considered, and the one most often overlooked. Unless the manager of a mine is willing to stake his reputation on maintaining the grade and tonnage of ore that he has estimated for milling purposes, it would be advisable to have this checked by thorough sampling and measurement by an independent engineer who is skilled in this particular work.

If insufficient ore is found to be developed to warrant the building of the plant, further development should be prosecuted until that is assured. If the plant is predicated on future ore development, the owners should be made fully acquainted with the facts and of the chances they are taking.

2. Ore too low in grade to be profitable. In every operating mine, a grade and tonnage of ore that must be maintained to cover the costs of mining, development, milling, marketing, taxes, and overhead can readily be determined. This may be termed the "Critical Grade." If this grade and tonnage cannot be maintained, the operation will show a loss. Too often when it is found impossible to maintain this grade and tonnage, development and other important work are curtailed, which almost ineyitably leads to closing down. With careful study, and thorough knowledge of mining conditions and costs, together with the metallurgical test results, this "Critical Grade" can be estimated with close accuracy, and should be used as a yardstick in deciding when and if a mill is warranted.

An exhaustive study was recently made by me of a large low-grade gold mine. This property operated a 50-ton per day plant, and by selective mining had maintained a grade of $14 per ton for the preceding year. Analysis of the costs for that year showed that at that tonnage it required a mill-head value of $10.20 to meet total expenses. On a 100-ton-per-day basis, the required grade was estimated at $7 per ton, which was proved correct when the plant was enlarged to that tonnage. On a 200- and a 500-ton per day basis the required grade was estimated as $4.80 and $3 per ton respectively. This estimate was predicated on more modern and efficient methods in both mining and milling, which would be warranted by increasing to that tonnage.

3. Insufficient finances available to meet emergencies. To be efficient, a small plant should be completely equipped, and maintain in stock supplies, replacements, and repair parts necessary to insure continuous operation. Finances must be available to cover operating expenses until the plant is paying its way, and to meet emergencies, and to make any necessary changes that may be required.

If the estimates are too low, and funds are not available to finish and equip the plant properly, resorting to makeshifts and economies in an endeavor to "get by" may bring disastrous results and insurmountable operating difficulties.

4. Inadequate and inefficient machinery and equipment. During the past generation there have been revolutionary advances in the equipment for the crushing, grinding, classification, and treatment of ores. During that time a

vast amount of equipment and processes have been devised, most of which have been discarded, and others developed into the highly efficient practices of today. This development has been accomplished in large part through the cooperation of established mining companies which could afford to experiment.

When a new mill is projected, pressure is often brought to bear to install equipment and processes as yet unproved, and for which exaggerated claims are made. The initial plant on a developing mine can seldom afford to experiment, and should install nothing but standard and proved equipment which the average operator is experienced in operating.

The economy of using second-hand equipment is often justified, if it is in good condition and fits into the flowsheet. Any second-hand equipment, the manufacturer of which has gone out of business, will prove an expensive economy if repair and replacement parts cannot be obtained. Equipment, either new or second-hand, that is bought because it is cheap will usually be found inadequate and inefficient, and will result in operating problems that are generally difficult to correct.

5. Adoption of improper metallurgical methods. This is usually the result of installing unproved equipment or processes which have not been thoroughly developed, or of accepting the advice of unqualified but plausible metallurgical "racketeers" whose only aim is to sell cheap equipment, or of failure to test the ore thoroughly, so that an effective flowsheet can be developed.

Every piece of machinery that is accepted as standard in present-day metallurgical practice has gone through a long and expensive period of research and development, and any deviation therefrom will almost inevitably lead to serious operating problems. If difficulties arise from nonperformance of equipment made and recommended by responsible manufacturers, they will unhesitantly spend time and money, and provide the services of their best engineers, to correct them.

Crushing, grinding, and classification constitute the most expensive step in the treatment of most ores. If this equipment is standard, properly installed and coordinated, and handled by experienced operators, operating problems will be rare in that department.

Kilowatt-Hours Required Per Ton of Ore Treated Per 24 Hours

	Tons Per 24 Hours			
	150	100	50	25
Straight flotation	30	33	36	42
Gravity concentration ...	22	27	30	36
Cyanidation (all slime)..	32	37	42	46

The method and equipment to be used in the crushing and grinding of the ore to the best economic advantage in a small plant depends on its physical character as it will be delivered to the crusher bin. If the ore is of medium hardness, or soft, and is wet, sticky, and contains much gouge, it is usually found to be more economical to crush in single stage to 1½ to 2 in., using a low discharge grate mill for final reduction. If the ore is hard and fairly dry, two-stage crushing to ½ in. or less, will be in order, and either a grate or overflow type of mill may be used. Secondary crushers in the smaller sizes are not adapted to wet, sticky ores. Swing jaw crushers of the Wheeling or Universal type have proved to be satisfactory where single-stage crushing is indicated. It is sometimes advisable to adopt single-stage crushing to start, and lay out the plant so that a secondary crusher can be installed later if it is found necessary to increase the tonnage.

The proper treatment for the ore after it is ground to the required mesh is a separate problem. Test results from responsible laboratories indicate the proper treatment for the ground ore, and furnish test data that will enable the metallurgist or qualified mill operator to select the type of equipment necessary to complete the process.

6. Hasty decisions and estimates made without thorough study of all facts involved. It is unfortunate for the mining industry that so many successful business and professional men in other lines, who have acquired mining interests, feel qualified to make off-hand, important decisions in regard to mining, that a qualified and experienced engineer would not dare to make without weeks of systematic study.

Experienced and qualified mining men would seldom or never make a decision to build a mill on a developing mine without a thorough and exhaustive study of all the facts and economics involved. If insufficient ore reserves were developed to warrant a plant, they would continue development, rather than spend money on a plant that would probably be a disappointment.

Many small mines are owned and directed by business and professional men, who after seeing a few samples of commercial ore taken from the mine, decide that a mill must be built immediately, and too often instruct the management to start construction at once. The usual result is a poorly planned, ill-equipped plant, costing more than expected, and with insufficient ore developed, it is soon forced to shut down, with another failure marked up for mining.

The management of a developing mine may at any time be called upon for a prompt decision on the advisability of, and on the cost of, constructing a milling plant. To be fully prepared to make an accurate and intelligent decision, during the development period the manager should study and tabulate all the factors that can be predetermined and keep up to date the available tonnage and grade of developed ore.

As soon as development work has progressed to a point where a mill can be considered as a near future possibliity, composite samples that will accurately represent the character and grade of the available ore should be tested in a well-equipped, responsible laboratory, to determine if it is amenable to standard methods of flotation, gravity concentration, or cyanidation. If not, the development of a satisfactory process may require months of research work, and it is well to consider that there are many types of ores for which no satisfactory milling process has yet been devised.

The amount of available water should be studied and the means and cost of delivering it to the plant estimated. In ordinary operations the tons of water, required per ton of ore treated is as follows: Cyanidation, 1 to 1½; flotation, 4; and gravity concentration, 8.

The cost of bringing power to the plant, or of producing it, and power rates should be determined. For general estimating purposes, the amount of power required for small plants is tabulated below, in kilowatt-hours per ton treated per 24 hours:

Acquisition of a site for tailings disposal and means of impounding tailings when necessary to prevent unlawful stream pollution may be of great importance, and its cost is often greatly underestimated.

Adequate fire protection, and insurance expense, which is usually about $3 per hundred dollars of insurance carried, should be considered in the estimates.

A mill site should be selected which will permit the economical handling of the ore. The bed rock should be tested, so that the grading of roads to serve the plant and the cost of grading and rock excavation per cubic yard can be estimated.

In severe climates, minimum temperatures and maximum snowfall should be recorded, so that structures will be properly designed to carry the snow load and conserve heat.

Prevailing wage scales of mill wrights, mechanics and laborers, operators, and other labor should be tabulated.

All equipment and material that ordinarily enters mill construction not connected with the process equipment should be tabulated with unit costs, as: lumber, cement, gravel, concrete mixers, tools, chain blocks, jacks, gal-

vanized iron, nails, windows, pipes and valves of various sizes, electric wiring, lighting conduit, change room equipment, heating units, and facilities for housing and boarding the construction crew.

To prevent underestimating the finances required, all the preceding factors should be carefully analyzed and estimated before details of the cost of the process equipment are determined from the metallurgical test work. As considerable time and study is necessary to accumulate these data, and failure to do so may result in hasty and erroneous estimates, the importance of preparing these data in advance cannot be overestimated.

Whenever the owners or stockholders of a mine appropriate the money for building a mill, it is with the thought that the appropriation will be returned by the successful and profitable operation of the plant, and that the plant will be completed within the appropriation, for which the management is usually held to strict accountability.

7. Metallurgical test samples not representative of mill heads. Great care should be exercised that the samples sent to the metallurgical laboratory should represent accurately the grade and character of the ore that will be delivered to the mill bin. The simple air drying of many ores changes their physical characteristics to such an extent as to give misleading results in the laboratory. To prevent drying in transit, they should be sealed in an air-tight container as soon as possible after being taken.

In general most ore deposition is associated with decomposition of the adjacent wall rock, resulting in decomposed rock, gouge, and primary slime, which have a definite and adverse effect in most metallurgical operations.

The engineer should estimate the amount of this dilution that will occur in mining the orebodies, and that proportionate amount should be included in the samples sent to the metallurgical laboratory. As most run-of-mine samples taken for assay are taken only across the vein, assay rejects should never be used for metallurgical tests.

In Conclusion

If full advantage is taken of the present advanced state of mining and metallurgy, there is no reason for any milling plant to have serious operating problems, or to fail to come up to reasonable expectations. If these problems develop, an understanding of their fundamental causes will be necessary to correct them.

Orebodies can and should be developed to allow accurate sampling and measurement of tonnage and grade. Competent engineers can closely estimate the per ton cost of mining, and the amount of dilution that will ensue, and from that the grade of ore that will be delivered to the mill.

Equipment is available if properly selected and coordinated, to crush, grind, and classify any type of ore, and the cost of this step can be accurately predicted. No reputable metallurgical laboratory will render a report on ore treatment that cannot be duplicated in practice with available and properly coordinated equipment.

From these data a "Critical Grade" and tonnage can be established. To insure a profitable operation this tonnage and a grade higher than the "Critical Grade" must be maintained.

In the Small Cyanide Plant

Here questions of management or organization as well as of operation may give rise to various problems

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IN RESPONSE to a request for a discussion of the practice and problems involved in the management, organization, and operation of a small cyanide mill, I have set down the following notes. Although these are not at all complete, some may find them useful in reviewing this extensive subject, the importance of which is often underestimated.

Conditions relating to the management of plants of this size may be divided roughly into three classes:

1. The mill may belong to a subsidiary company with the chief technical and advisory service provided through a central or parent organization.

2. An experienced consulting engineer may be engaged, who directs the work and makes periodic visits, besides giving advice as required.

Under either of these arrangements the mill management is able to draw upon a broad knowledge and experience to assist in solving its problems.

3. The mill is operating under a single company. Here, the successful direction is likely to depend almost wholly, if not entirely, on the manager and his mill superintendent. The task of selecting these men therefore increases in importance, and the responsibility for performing it is relatively greater than under the first two divisions. Other things being equal, the more remote the location, the greater the initiative required. The comments which follow bear on plants of this third classification.

Staff—Management should guard against having a staff that is too large and too costly in proportion to the size of the operation. Occasionally, disclosures have shown instances of excessive operating and accounting costs that could have been avoided. Where circumstances permit, two departments, or in rare cases more than two, can be combined under one head. This fixes responsibility more closely and should permit maximum cooperation. It also requires provision of living accommodations for fewer men. Under these circumstances the company can afford to pay the department head more liberally.

Departments that often can be combined in a satisfactory way include: (1) The assaying or engineering and surveying. The assayer should be directly under the manager's control so that the assaying is independent of the authority and influence of mill and mine superintendents and the engineer. (2) Master mechanic and electrician.

The staff should be encouraged and helped to do the following things:

1. To maintain as close contact as possible with the heads of departments of large mining companies and their assistants.

2. To subscribe for and study the best publications dealing with milling problems. Those eligible should join the national technical societies and take an active part in local section meetings. At the latter, the staff should be given opportunity to contribute papers.

3. To visit the larger mines to learn what they are doing to improve practice and equipment.

4. To co-operate with a not too distant mining school and the metallurgical department of the nearest Bureau of Mines. The advantages of their laboratories and skilled service where available should be utilized.

Maintenance and repairs—Hoisting and usually crushing should be in charge of a first-class master mechanic. Tonnage of ore handled, the size to which it is crushed, and the time of crushing should be arranged in cooperation with the mill superintendent. Electrical equipment relating to hoisting, crusher station, and mill should be under one supervision.

Responsibility for inspection and repairs of mill equipment should be-

long to the mechanical department. Inspection should be as frequent as its condition calls for, to maintain high efficiency of operation.

Capable daily inspection of all electrical equipment should be made covering units that operate continuously. This service can do much to minimize shutdowns.

Records of desirable repair work should be kept to permit it to be planned. Whenever inspection indicates that a major shutdown is necessary for repair, replacement, or alteration, the following factors should be considered:

1. Before actually shutting down (unless in an emergency) all necessary equipment parts, so far as known or expected, should be on the spot. These should be inspected, fitted into a duplicate unit when available, and made ready to go into place.

2. Underground and surface storage of ore should be checked and plans made to shut down at such time as will cause the least interruption or inconvenience.

3. One should have available a crew consisting of the most capable mill operators. Next, one should "grind out" or prepare the circuit so as to have the mill crew or the repair crew or both ready when their work starts.

4. Time studies should be made of all major repair jobs for future guidance.

5. All work affecting running time should be planned so that the various department jobs can be carried on concurrently, so as to cause the minimum production loss.

Testing—Opportunities for making tests should be seized. In a large mill testing can be done at any time on one or more of several circuits. This is not practical, however, in a small one-circuit plant. It is therefore desirable to take advantage of each opportunity during the shutdown of a part of the plant, or other favorable time, to make extraction, capacity, and other tests. A careful checking of various parts of the circuit through special sampling when the plant is being operated under changed conditions frequently leads to improvements. It is of course important to maintain maximum operating time and mill extraction. It should also be recognized that any interruption or disturbance in a well-balanced circuit almost invariably causes tonnage loss and decreased efficiency.

Such opportunities for testing arise, for example, when the crushing department is "down," so that the ore storage bins would be empty if reduction were maintained at the usual grind. Under such circumstances one can try grinding finer, or change the dilution. Also, if the grinding section is shut down, the following can be tried: (1) Increased time of agitation or a change in dilution, or both. (2) Precipitating at a lower or higher "pregnant" value. (3) Filtering at a greater dilution, varying filter speeds, etc. (4) If double filtration is normally employed, one can change to single; or filter before, during, and after agitation.

A rule of testing which in general should be strictly followed is: Try only one change at a time. Carefully note the effect. Confirm as nearly as possible any indicated advantage. Estimate closely the dollar saving before recommending that additional equipment be purchased or other major equipment changes be made.

Experimental laboratory—A small, well-planned testing laboratory under the direction of a capable mill superintendent is worth consideration. Unless the ore is unusually free-milling, it is warranted and usually proves to be an economy. Equipment should include: Grinding, preferably, in closed circuit with a classifier; agitation, by pachuca or bottle, or both; filtering, by pressure or vacuum; mechanical sizing; and suitable means of weighing and drying. Additional desirable units are a Haultain Infrasizer, a Haultain Superpanner, and a microscope for examining mill products.

Sampling—A general analysis of the mill solution and barren solutions should be made occasionally through a suitable outside agency. This may help in identifying troubles.

Systematic sampling, laid out after study under competent direction, should be daily routine. The original mill design plays an important part here.

Aside from the routine daily samples taken by the mill men, special sampling by some capable person, preferably one who can otherwise be employed in the experimental laboratory, is desirable. This person should have the responsibility for taking and preparing these special samples and do the sizing. All such sampling should be done often enough and over a sufficient period of time to confirm that the general results are reliable and to determine if changes in practice or equipment are justified.

Some Precautions

So far as practical, care should be taken with samples to avoid: (1) Sample contamination. The usual safeguards are: Use of enamelled or glass containers, seeing that these are thoroughly cleaned first. When there is chance of splashing, dripping, or spilling the samples, placing them under suitable covers, in cabinets or means of protection. Keeping the mill clean and sluicing only with solutions from the section being cleaned. (2) Substitution or alteration. Under certain conditions it is justifiable to lock up such things as revolution counters, recording instruments, charts, pregnant and barren solution samples, and automatic samplers. When this is done, the mill superintendent or someone authorized should have full responsibility, including that for collecting and preparing the samples.

(3) Carelessness in washing, drying, handling, and reduction of samples for assaying. The ball-mill head sample, due to its relatively coarse size and erratic value, is one that in general should be used only for an approximate valuation. However, with proper care the tonnage can usually be determined thus within fairly close limits. Actual mill-head values should be calculated on bullion plus tailing and soluble loss.

Operating records—Daily record forms should be carefully prepared and kept showing the operation throughout the crusher station and mill. The records should give a comprehensive account of all items affecting operation. It is usually best to start with tentative forms and later revise these, if necessary.

It is desirable to permit quick comparison by the mill superintendent or others, to show operation in respect to major items under such headings as "Today," "Month to Date," "Last Month," and possibly "Year to Date." These would include principally the tons milled, tailing loss, tons precipitated, press tails, indicated production, and extraction.

Mill design—It is important, both as to extraction and cost, that the building, equipment, and arrangement be well planned. It should provide (a) flexibility as to possible change of tonnage and flowsheet; (b) means for convenient and suitable sampling; (c) proper facilities for estimating both solid and solution tonnage; and (d) a tailings disposal system which is adequate and dependable. If pumping is required, at least duplicate tailing pumps, and preferably a duplicate pipe line, should be provided.

Tonnage estimation—Ore tonnage should be automatically and continuously weighed. Equipment for these operations is expensive, however, and where not supplied, careful estimation should be made from samples taken from the ball-mill feed belt, and this should be checked by tonnage samples taken by a tonnage tank in the circuit. When tonnage is being estimated from ground pulp, extreme care should be taken in determining the specific gravity and the time required to fill the tank.

Accurate determination of solution tonnage is also important, but less difficult. Means commonly employed include: (a) A meter, such as the Venturi; (b) weirs of various types; (c) duplicate storage tanks with float indicators, one tank filling while the other empties; and (d) determining the rate of flow at regular intervals by measuring the rise or fall of solu-

tion level in a calibrated tank of relatively small diameter.

Whatever the method used, care should be taken to insure accuracy. Value "called for" in the precipitation press should normally check closely with the bullion recovered.

Monthly summary sheets — Where summaries of unusual expense are desirable, estimates should be made covering the proposed special work and shop orders should be issued, so that costs may be properly analyzed instead of including these items under general mill costs, for example, to the discredit of the mill superintendent. To avoid widely fluctuating monthly costs, it is also desirable to carry reserves for such major items such as crusher and other parts.

Tonnage handled, life, and make, and like factors in respect to major replacement parts should be included in the record so that fair comparisons may be drawn.

Charts and tables—Proper tables should be made for use of solution operators. Solutions for indicating lime and cyanide strength should be standardized to read direct in pounds per ton. Daily and shift tonnage charts or graphs, if conspicuously placed and their importance emphasized, are often helpful in increasing tons milled. However, extreme care should be taken not to allow this possible source of competition between shifts to cause unjustified sacrifice of extraction.

All important records should be systematically studied daily by a capable manager and analyzed in quest of possible improvements in operation, increased tonnage and extraction, lower costs, and other economies. To facilitate this, the manager should prepare a form containing such data as will give him the information he desires. He should then arrange to have this completed promptly each day for his reference. The record should include: (a) Lost operating time and cause of interruptions, also over-all extraction. (b) Extraction made in various parts of the circuit, as in grinding, thickening, agitation, filtration. (c) Tons milled. (d) Value precipitated.

Lists of electric motors and their location should be made and kept up to date. This information should include the horsepower, speed, type, shaft and pulley size, frame number, and other characteristics of the units in service as well as those stored as spares. Such data permit prompt substitution of any suitable motor in event of a breakdown.

Current lists of all essential spare parts should be kept, and on these should be given the place where the parts are stored.

Moisture in ore—It is important to avoid execessive moisture in the crushing circuit. Much trouble is often caused and added labor cost incurred through lack of cooperation between the underground and mill management in this matter. Where closed-circuit screening is employed, and particularly if fine crushing is done, high moisture is a distinct disadvantage.

Lubrication—Only those oils and greases and the method of applying them that are best suited for the equipment installed should be used. The error should not be made of leaving this very important problem to anyone not competent. A procedure usually found reliable has been to secure from the manufacturer of each major unit of equipment a specification for a suitable lubricant, which, if possible, can be had from more than a single source. These recommendations should then be checked with experts from oil companies and others who are dependable. Proper oils and greases can thus be had with assurance of minimizing damage to equipment and avoiding inefficient, costly operation. It is desirable to buy as few different kinds of lubricants as practical, and thus to take the fullest advantage of quantity bought on contract.

Power — Graphic recording meters should be used on the normal electric power supply to indicate peak load as well as the power consumed throughout each 24 hours. A careful study of such records and close cooperation between departments will do much to reduce these costs.

An auxiliary supply of power should be provided. This is especially needed if only one long transmission line serves the mill. The standby unit must be in perfect condition and ready for immediate starting. Prompt investigation of any failure to start or carry the load should be made. Severe criticism or dismissal is warranted where carelessness is proved.

Safety—A plant should be kept safe and all workmen should be safety-conscious. Only safe equipment and methods should be used. Safety pays profits.

Conclusions

Adequate records are vital to best mill practice. Too many entries, however, cause waste of time. But lack of certain information may result in overlooking inefficient and costly operation.

Forms carefully prepared and adapted to the particular milling circuit in use are necessary.

Close cooperation between shifts and metallurgical control are essential and must be maintained. Too great emphasis cannot be placed on the benefits usually derived from uniformity of chemical strength, rate of milling, fineness of grinding, strength of solutions, and like factors.

Technical training combined with substantial and varied practical experience should be applied, with aggression and persistence, to the problems of the small cyanide plant. This is cheap insurance against a wide variety of mill troubles. Aside from being an experienced and successful operator, the man in charge should be capable of organizing and directing the undertaking efficiently. Moreover, he should be able to inspire confidence, secure cooperation, and get results.

Excessive losses can easily occur. They may derive from solid and soluble values that are wasted, or from high costs, carelessness, ignorance, or theft. It is not enough simply to show a profit. Every justifiable effort should be made to reach and maintain the highest practical efficiency obtainable throughout the operation.

▼ ▼ ▼

A Small Mine in Washington

THE MOUNTAIN LION mine, in the Republic district, Washington, is controlled by Knob Hill Mines, Inc., though owned and operated by a separate organization, according to Bureau of Mines Information Circular 7123, June, 1940. It is being worked through a vertical shaft 640 ft. in depth. This shaft, consisting of a single hoist compartment and a manway, has stations cut at 125-, 300-, 400-, and 600-ft. levels. On the 300-ft. level is an adit 700 ft. in length.

A steam hoist with wood-fired boiler delivers the ore by skip to a 100-ton bin on the surface, whence it is trucked to the Knob Hill mill. An electrically driven 650-c.f.m. compressor replaced an older, smaller unit.

The mine is producing about 75 tons of milling-grade gold-silver ore daily. The present ore reserves and recent development work are encouraging enough to warrant increasing production to 100 tons daily.

Prospecting is now done by long-hole drilling. The equipment comprises a heavy-duty Leyner drill using 30-in. sections of 1¼-in. round drill steel; the steel is coupled, making a unit capable of drilling holes 80 ft. long. The sludge samples have proved reliable.

As drilling is scattered widely throughout the mine, Jack bits are used in regular operations to save expense in transporting steel. The ground, which stands well and requires little timbering, is conducive to shrinkage stoping. Part of the vein near the surface is mined as a glory hole.

The personnel consists of a crew of about 25 men divided into two shifts and supervised by a mine superintendent and night foreman. All mechanical work is handled by the mine-shop force at Knob Hill; all engineering, assaying, office work, and general supervision by the Knob Hill staff.

A Unique Small-Scale Smelter

In three years of successful operation the Philippine Smelting Company's plant, equipped with a Mace furnace, has given excellent performance

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THE PLANT of the Philippine Smelting Company is about 120 miles on an air line southeast of Manila, near Mambulao, on the island of Luzon, in the Philippines. The first unit was erected and put into operation early in 1937.[1] The plant has now been running successfully for more than three years. Several additions and metallurgical improvements have been made. This has increased earnings and made it possible to reduce treatment charges.

This operation is unique in that it is one of the few continuous and completely successful small smelting units in existence, and also in treating material having extremely high gold values per ton.

The ores in the Paracale gold mining district which the smelter serves are comparatively high in base-metal sulphide content. The most abundant sulphide is pyrite, but varying amounts of copper, zinc, and lead sulphides are present also. For this reason all the mills use flotation either as a principal or auxiliary method of gold recovery.[2]

Flotation concentrates produced in the district are locally called "copper" concentrates, although the prevalent base metal may be lead, zinc, or iron, the reason being that copper, until recently, was the only marketable base metal. The average analysis of the concentrates is represented in that of the smelter feed, given in Table I. Arsenic and antimony occasionally occur but not in sufficient quantity to accumulate in plant secondaries.

Before the smelter was built the local mines shipped approximately 1,200 tons of concentrates per month to American smelters. Not only was the freight rate high, but sacking charges, insurance, smelter charges, and smelter value deductions took a large slice out of the gross value. It was realized that a small local smelter could not hope to compete with large American smelters in treatment cost. However, the low copper content of the concentrates made local smelting feasible purely by the reconcentration of values. This gave a saving in freight which offset the smelting costs. The concentrated product took a lower smelter rate and the value deductions were less per unit.

Ratio of concentration has averaged 12 to 1. Most of the iron and zinc, with the insoluble, is eliminated in the slags. The gold and silver, up to

[1] *E. & M. J.*, Vol. 138, p. 414, 1937.
[2] *E. & M. J.*, Vol. 138, p. 412, 1937.

Plant of Philippine Smelting Company, at Mambulao, in the island of Luzon

recently, have been shipped in the form of copper matte or bullion.

The flowsheet in Fig. 1 represents present and proposed plant practice, and is largely self-explanatory. The following history shows the development of the process and may be of interest because of abnormally high gold content of the feed:

When the plant started in 1937 approximately 30 tons of concentrate per day was treated. Today it treats 60 tons and rising freight rates have brought inquiries from producers outside the district.

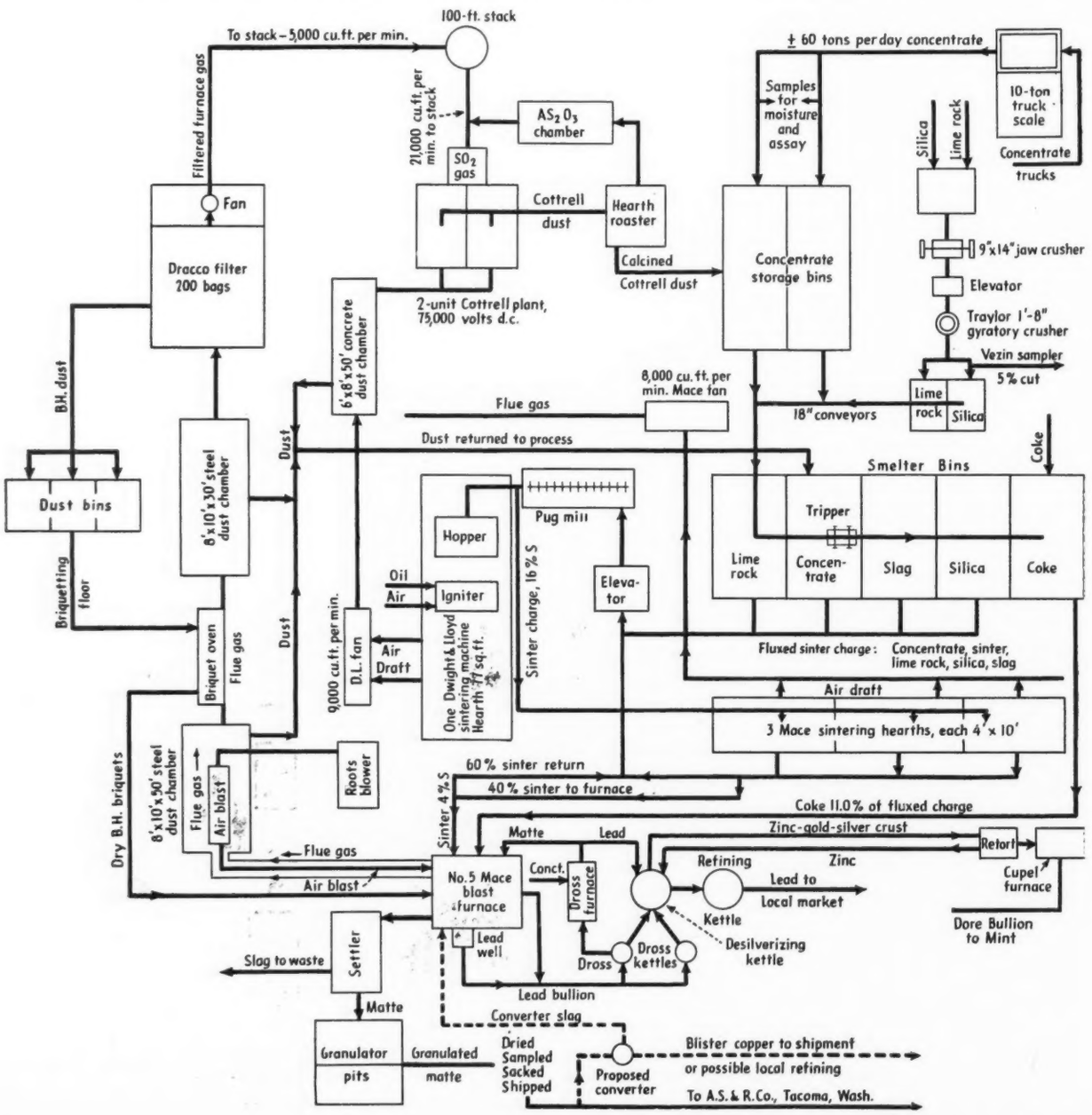
During the first three years the plant operated essentially as a copper smelter and no lead was saved. The concentrate was fluxed with a minimum of lime rock and siliceous high-grade ores, and was sintered on two Mace hearths and one Dwight-Lloyd machine. Because of the high sulphur content of the pyrite, a large part of the sinter is returned for double sintering. The sulphur in the finished sinter is about 4 per cent.

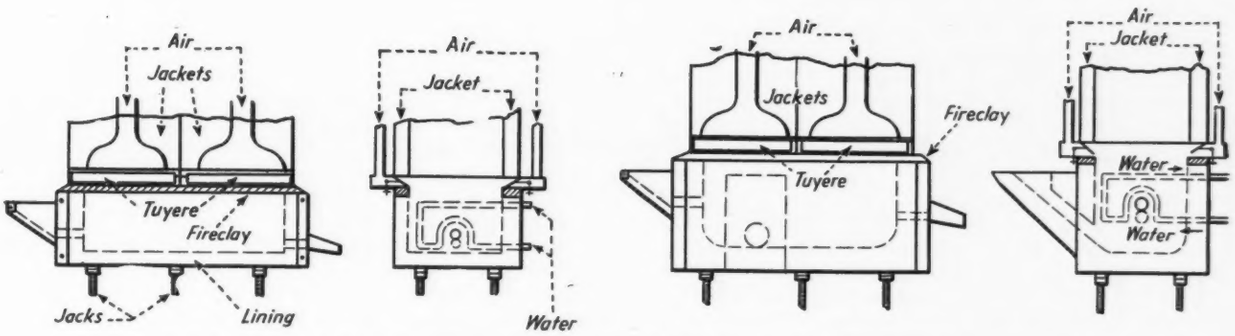
During the first two years the sinter was fed to a No. 4 Mace copper-matting blast furnace of nominal 50 tons daily capacity. Later a No. 5 Mace blast furnace of 100 tons daily capacity was installed and is now in steady use, replacing the small furnace. Minor improvements have been made, but in general the Mace furnace has given excellent service and the Mace company has incorporated many of these improvements into its recent furnace design. The full-length box tuyeres below the jacket permit running the furnace at comparatively low blast pressure (6 to 8 oz.), giving hotter matte fall into the crucible and lower dust losses than the old conventional pipe-type tuyeres located several inches above the jacket bottom (Fig. 2) and using much higher air pressure.

A two-unit Cottrell plant, treating sinter machine gases, was installed in November, 1938. This investment was liquidated by the value of the metals in the dust recovered the following year.

In December, 1939, a Dracco bag-house unit was installed for filtering

Fig. 1—Flowsheet of the plant of the Philippine Smelting Company at Mambulao, on the island of Luzon





Figs. 2 and 3—Left, the shallow matting crucible and, right, the deep lead crucible adopted early in 1940 to permit recovery of the lead

the blast-furnace gases apart from the sinter gases. This not only relieved the overloaded Cottrell treater, but made it possible to recover a larger portion of the lead. Spectrographic analysis of the burned baghouse dust is given in Table II.

The burned baghouse dust is briqueted, dried, and returned direct to the blast-furnace charge.

At the time recovery of baghouse and Cottrell dust was started it was realized that the lead would serve as an excellent collector of the precious metals, largely replacing copper in this respect. The advantages were many. Aside from a large quantity of lead being recovered in a marketable form, it became possible to extract the precious metals from the lead bullion by well-known methods and ship these in a doré bullion directly to the mint. The lead is disposed of locally, thereby avoiding the high transpacific freight on gold-bearing base-metal bullion.

For these reasons the design of the furnace crucible and the furnace operating procedure were changed in the spring of 1940 to permit recovery of lead. (Fig. 3). The furnace crucible was made deeper and a lead well was attached to the side. The constant overflow of matte and slag to the settler by the inverted siphon spout was retained. The furnace is now run with a high charge column to reduce the amount of lead burned off.

The furnace operates with a blast pressure of 8 oz. and handles 100 to 150 tons of fluxed sinter per operating day. Coke consumption is approximately 11 per cent of fluxed charge weight. The large matte fall insures steady flow from the furnace, thus eliminating all furnace tapping difficulties, and also makes frequent changing of settlers unnecessary. Furnace campaigns of over 40 days have been made with no settler troubles developing. Due to high copper on the charge, some trouble has been experienced in keeping the lead well open. When this happens the well is allowed to freeze up and the crucible is tapped from a special tap hole at back of furnace. Analysis of typical products while running with a shallow copper-matting crucible are given in Table III and while running with the deep lead crucible in Table IV.

The blast-furnace campaigns usually last 25 days each month and often the crucible and settler are merely drained and started again without relining. Flexibility of this intermittent operation facilitates periodic inventory of our large gold values in process, and operation is adjusted to incoming tonnage. The furnace can be stopped and started again within 48 hours at small expense. This flexibility would not be possible with a reverb type furnace.

The copper matte and bullion formerly carrying the gold and silver values were shipped to the Tacoma smelter. At present copper matte still goes to Tacoma but no copper bullion is shipped. A small copper converter is now going into service to convert the copper matte to blister copper. The lead will be recovered in the baghouse from the converting operation and the tonnage shipped will be reduced by more than half.

Lead bullion carrying approximately 100 oz. of gold per ton has recently been shipped to the Selby smelter. This lead bullion is now being degolded and desilverized locally. Doré bullion is shipped direct to the San Francisco mint by registered mail. Approximately 100 tons per month of desilverized lead is being refined by the Harris process of caustic soda dezincing and is being sold in Far Eastern markets.

Copper, lead, nickel, and zinc values have been so small in the past that no emphasis has been attached to their recovery. However, since the increase in cost of transpacific freight rates and insurance it has become important that we either cut down the bulk of shipments by further concentration, or produce finished products which can be sold locally. Investigation is now under way to determine the possibilities of installing an electrolytic tank house for the separation of copper and nickel. The Bureau of Mines has recently completed a series of tests in which a copper-nickel matte is blown to white metal, cast into soluble anodes, and the copper and nickel recovered apart in a nearly refined form. Further advantages are realized by having the precious metals in a product acceptable to the United States Mint.

At present, about 8 tons of nickel monthly finds its way into the plant as an undesirable element. Large quantities of nickel-bearing siliceous ores are rejected on account of the high nickel content. The electrolytic plant would not only give us salable products but might turn a stiff nickel penalty into a profit.

Amount and value of the metals output of the plant in 1939 are given in Table V.

The 1940 output of metals will be somewhat higher in gold. The amount of lead saved will be increased to near 100 tons per month with operating practice now becoming effective.

Every effort is being made to retain the gold and silver in the lead bullion, so that these precious metals may be reduced to mint-grade bullion. Present effort is toward raising the lead and reducing the copper on the blast-furnace charge. This is accomplished by returning some desilverized lead bullion to the charge and by sending high copper secondaries to the converter instead of returning them to the blast furnace.

The dross skimmed from the blast-furnace lead bullion in the first kettles is remelted with a small amount of pyrite concentrate in a 1-ton Monarch reverberatory-type furnace. This remattes the copper and the charge is poured into pots as soon as thoroughly melted. The matte, which carries comparatively little gold, is taken from the pots as soon as solidified. The molten lead is then poured into the degolding kettle. Thus nearly all of the gold in the dross is returned to the drossed lead bullion, so that it finally comes out of the local process as doré bullion. Little speiss is formed in remelting the dross because the arsenic present is small.

At one time arsenic accumulated in the Cottrell dust. Recently, arrangement has been made to roast this dust separately, eliminating most of its arsenic content direct to the stack. Condensing chambers are now being built to connect with the hoods of

this roasting operation to recover some white arsenic for local sale.

The beneficial effect of the use of lead as principal precious metal collector in furnace operation is evident by comparing gold and silver assays of slag and mattes in Tables III and IV.

When operation began in 1937 difficulty was had due to inexperience of native labor. None of the men had had previous experience in anything even faintly resembling the operation of a blast furnace. This difficulty was corrected in a surprisingly short time and Filipino operators are now fairly competent, although approximately four times as many men are employed as would be needed in a similar operation in the United States.

Most of the early difficulty in operation was caused by the poor grade of coke used for fuel. Different kinds of coke were used at that time, consisting of Australian, Japanese, and Indo-China cokes and local gas coke. None of these were satisfactory and Belgian foundry coke was finally used exclusively. Since September, 1939, it has become impossible to obtain Belgian coke. We now use the best available West Virginia foundry coke, which costs $35 per long ton delivered at the plant. This is the largest single cost of operation.

All electric power used is obtained from the near-by diesel power plant of the San Mauricio Mining Company.

Local operating costs have shown a drastic reduction as the tonnage treated has increased, and although still not comparable to large American smelter costs, they are reasonable considering the high local cost of fuel and supplies. Recent metallurgical improvements have been self-liquidating, as will be the proposed converting of copper matte and possible local refining of copper, as well as lead. Therefore, these extensions entail no rise in treatment charges to the mines shipping to the local smelter. On the contrary, the company policy is to pass benefits of future improvements in process to the mines in probable further reductions in treatment charge.

Other reasons that local costs and treatment charges are not comparable to American practice are that these include cost of abnormally high freights on our products to the refinery, and insurance and interests costs on the large values constantly in transit. Ordinary marine risk and war risk insurance alone cost approximately $3 per ton of concentrate received.

Interest on values in transit amounts to $2 per ton received. Freight on matte to the United States West Coast is now $15 per ton, and on blister copper is $25 per ton. Because of these unparalleled conditions there is no object in giving detailed costs herein. It is sometimes difficult to persuade shippers to consider our charges in the proper light—namely, in comparative over-all cost of marketing their flotation concentrate. Different mines have various ways of entering the many costs involved in liquidating the values contained in their mill concentrate product. At times several cost items find their way into mine general expense accounts instead of concentrate marketing cost account, whereas the local smelter treatment charge quoted, covers all such expense from the time the concentrate is delivered at the plant until values are marketed.

The present standard charge is $20 per dry short ton. Metal deductions in general are comparable to American custom smelter practice. It is noteworthy that both copper and lead content are paid for in the concentrate received.

Local operating cost in 1939 was $14.30 per ton treated. Cost of liquidation of metal products value actually exceeded this figure slightly, and the discrepancy between the sum of these two figures and the treatment charge was covered by a small gain in the turnover of the metals value.

The smelter staff consists of seven Americans. Also employed are some 300 Filipino laborers. Many labor-saving devices taken for granted in American practice are not used here, for economic reasons. An example of this is our employment of nine men daily at $0.50 each to wheel slag to the dump. To move this slag by mechanical methods would cost far more than the $4.50 now expended.

The company has built a small *barrio* (townsite) for the employees. This consists of several duplex nipa houses. The camp is furnished with lights and water, and the sanitation is closely scrutinized by our Welfare Department. Recreational facilities are now being installed for the welfare of employees. This practice is general in the Philippine mining industry and has done much to promote better relations between labor and the companies. In the plant a building has been provided for the use of the men. This has lunch, shower and rest rooms. Safeguards and smoke hoods are provided wherever considered necessary to protect the men against industrial ailments and accidents. Safety-first instructions are given to *capatazes* (native foremen) by the director of the Paracale-Mambulao Mine Rescue and First Aid Association.

The company is fortunate in enjoying the management facilities of Marsman & Company, Inc. This arrangement materially reduces overhead expenses which would be necessary if any separate managementing arrangement was maintained. Hospital, medical, legal, accounting, purchasing, and technical facilities are all made available at comparatively small expense.

The success of this small but important smelting operation has been gratifying because of original doubt and lack of precedent regarding the degree of success possible in small-scale smelting. It has undoubtedly added substantial real net value to the mines of the district by savings in concentrate marketing costs made available to them. In the face of present general rising costs to gold producers, two reductions in charges and two reductions of metals deductions have been made in the past year. It is probable that further savings will be passed to the mines shipping to the local smelter, in the future, and that the Philippine mining industry will be served to advantage by the existence of this local smelter in the years ahead.

The smelter is now adding a lime-burning kiln. It owns and quarries a fine grade of lime rock near by. The burnt lime produced is not only in demand by the local cyanide plants but is particularly desired by the sugar refineries.

Table I—Analysis of Smelter Feed

Au, oz./ton	7.00	Zn, %	11.0
Ag, oz./ton	17.50	Ni, %	0.4
Cu, %	6.00	Fe, %	36.0
Pb, %	10.00	S, %	37.0

Table II—Spectrographic Analysis of Baghouse Dust

Pb, %	65	Al, %	1.8
Zn, %	5.0	As, %	1.0
Ca, %	5.0	18 minor metals, %	2.9
Cd, %	4.0	Silver, by assay, 0.15 oz.	
SiO_2, %	2.0	Gold, by assay, 0.01 oz.	

Table III — Analysis of Copper Matting Furnace Products, 1939

	Slag	Matte	Bullion
Au, oz	0.058	32.0	480.0
Ag, oz	0.582	165.0	345.0
Cu, %	0.642	50.0	40.0
Pb, %	3.0	20.0	30.0
Zn, %	15.0	6.0	4.0
FeO, %	35.0	.....	.....
Insol., %	32.0	.....	.....
CaO, %	10.0	.....	.....
Ni, %	.....	2.4	20.0

Table IV—Present Analysis of Lead Furnace Products

	Slag	Matte	Bullion [a]
Au, oz	0.020	6.50	110.0
Ag, oz	0.360	75.0	140.0
Cu, %	0.48	38.0	0.04
Pb, %	1.60	25.0	98.01
ZnO, %	15.0	6.0	.....
FeO, %	34.0	.....	.....
Insol., %	28.0	.....	.....
CaO, %	15.0	.....	0.04 As
Ni, %	.....	2.0	0.35 Sb

[a] After drossing and return of lead from remelted dross.

Table V—Plant Metals Output in 1939

134,608 oz. gold, at	$35.00	$4,711,280.00
599,103 oz. silver, at	0.71	212,363.13
1,565,365 lb. copper, at	0.12	187,843.80
536,268 lb. lead, at	0.05	26,813.40
Total value		$5,138,300.33

A System of Accounts For the Small Enterprise

An accurate, informing cost sheet is the primary objective in maintaining this and is essential to the successful operation of any mine

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THE MINE that is producing a complex ore containing, say, copper, silver, and gold, or lead, zinc, and silver, or some similar combination of metals, where the ore is partly of a sufficiently high grade to ship direct to a smelter and where the remainder is produced as concentrates, is probably as nearly typical of the mining industry in the United States as any property can be and raises most of the questions peculiar to mine accounting. Such a mine will usually sell its ore and concentrates to one smelter under contract to take the entire production, although it is not unusual for such contracts to specify the return to the mining company of all or part of the metal contents. The mine management then sells the metal at such times as seem to be advantageous.

In mining accounting the problems which present peculiar or unusual features have to do with valuation of property and costs of operations. Financial accounting for a mine is not essentially different from that of most enterprises and will not be discussed here. Valuation problems, from a corporate and a tax point of view, have been covered both in books and articles and in certain releases of the Securities and Exchange Commission.

The other important and ever-present feature of mining accounting is the determination of costs and, as a corollary, the valuation of inventories. The first principle of cost in a mining property is that there is no expense, with the possible exception of Federal income taxes, interest, and depletion, which is not part of the cost of sales of the metal produced, either as an expense in the current period or as a deferred expense applying to a succeeding one.

The first step in setting up a system or in determining an accounting procedure is to decide which is the principal metal and which are subsidiary metals or byproducts. Ordinarily, this is determined by the value of the product. Obviously, in a property where the ore contained, say, 15 per cent copper, 2 oz. of silver, and 0.25 oz. of gold per ton, the copper would be the principal metal. If, on the other hand, an ore contained 50 oz. of silver and 50 lb. of lead per ton, the silver would be the principal metal and the lead the byproduct. If, in a copper-silver-gold ore, copper was the principal metal, the values of silver and gold as paid for would be credited to the cost of copper at their market values. This is a correct application of the general principles of byproduct accounting and, in most cases, is the practical way of handling this question in a mine.

After the principal metal is determined, the next question is, on what unit shall the costs be applied, and the answer here is, so far as mining, milling, and transportation to the smelter are concerned, the ton of ore or concentrates. Cost of ore or concentrates will finally be distributed to units of the principal metal, but it must be remembered that we do not mine pounds of copper or ounces of silver but tons of ore and waste.

Costs of a typical mine are broadly divided between direct and indirect, or, as this latter is frequently termed, redistributable expenses. Direct costs include labor underground and labor, such as hoisting engineers and other surface labor, directly connected with mining; supplies such as explosives, timber, concrete used underground, and stores and materials consumed directly and immediately in mining. Indirect or redistributable expense covers principally the service departments, electrical shop, carpenter shop, blacksmith shop, drill sharpening where this is a separate department, material and supply warehouse, and general expense such as geological, engineering, pay office, or other accounting or administration.

The first process is to distribute costs directly to each operation or division without distinction between direct or indirect costs. As a rule, a careful classification of payroll and supplies will provide the basis for this distribution. In this condition the cost sheet will show labor, supplies, and expense distributed to the various operations and sources. The direct operations, mining (divided if desired between types of ore, or orebodies), milling, transportation to smelter, smelting, reduction, refining, and the like, will not be further distributed but will be increased by their proportionate shares of the indirect or redistributable expenses for service departments and general purposes. In certain operations the distribution may be made in proportion to labor hours or money in the various departments, or by some other arbitrary basis which may seem to be more applicable. If, for instance, 50 per cent of the hours worked in the blacksmith shop is devoted to the repair of mine cars and $1,000 worth of steel, bolts, and welding rod for this job has been issued to the blacksmith shop, it is obvious that tramming or underground transportation should be charged with half of the blacksmith labor expense and with the $1,000 worth of steel and other material used for repairs to mine cars. Where charges for stores or labor can be made direct to primary operations, it is sometimes preferable, as a matter of convenience, not to pass such charges through the shops or other redistributable accounts. If two types of ore are mined and the number of tons of one is 50 per cent of the number of tons of the other, unless there is some great disparity in conditions, it would be correct to charge one-third of the labor and supplies of the drill sharpening shop to one type of ore and two-thirds to the other. General expenses, including the pay office, may usually be distributed on a basis of labor. The expense of operating and maintaining the warehouse may be distributed on supplies used measured in money.

These methods of distribution are generally found to be sufficiently accurate, as what is wanted is not unit costs of extracting ore from a particular stope or level but the total cost of mining a given number of tons of ore in a given period. Where development work is going on, this can generally be treated in much the same manner as a separate type of ore. For instance, if the mine had a main orebody from which its commercial ore was extracted and was also engaged in drifting out on the same level in the expectation of finding another, it would be simple to keep the labor for drifting separate on the payroll and to keep the supplies issued separate for the mining and the drifting or development operations.

For a mine in the development stage —that is, before the commercial extraction of ore—the method of accounting is precisely the same as for an operating mine except that the charges are to development rather than mining. Any ore extracted incidental to development should be shown as a reduction of development expense

rather than as income. The distinction between the development period and that of the commercial extraction of ore is, broadly, that during development the purpose of the operations is to discover the nature and extent of the orebody and to make it possible to extract with profit the ore blocked out. When the operations are directed principally to the extraction of ore already blocked out, the development stage has ended and the operating stage has begun. It will generally be true that some development is going on in any operating mine and it is equally true that some ore extraction is generally taking place in any development operations. The distinction between the two stages in the life of a mine lies in the preponderance of one type of operation over the other. Obviously, once operations are begun, charges to prepaid or capitalized development cease except where an entirely new and distinct orebody is being developed. A situation sometimes arises where mining expense is incurred for the benefit of future operations after the development period has ended. Here it is permissible to distribute this deferred charge over subsequent operations, but, in general, such charges should be scrutinized closely and avoided unless clearly called for by the nature of the operations.

If two types of ore are mined, shipping ore and milling ore, and the conditions under which they are extracted are similar, cost of mining should be the same for each type of ore up to the point where shipping ore is transported to the smelter and crushing and concentration begin on milling ore. Cost of crushing and concentrating, including the operation of the mill, mill supplies, mill repairs, mill lighting and heating, and such of the services of the shops as are for the benefit of the mill, will be added to the cost of mining to obtain the total cost of concentrates. When all costs connected with mining and milling have been allocated to those two operations, the first stage of the accounting is complete and may be said to cover the cost incurred in producing the material which the mine has for sale—that is, ore and concentrates.

From this point on, costs cover transportation and smelting, reduction and refining. No special problems are present in determining and allocating transportation costs, which are still calculated on a basis of ton of ore or concentrates. If the ore and concentrates are shipped by the company's own trucks for all or part of the distance to the smelter, direct charges for trucking, such as labor and fuel, should be included as well as any services rendered by the shops or general departments.

The company's accounting for finished metals depends on the form of contract with the smelter, which may provide either for "treatment on toll" or for the purchase of the ore. In either case, the basis of the accounting for metals will be the assay agreed upon, before or after umpiring, between the mine and the smelter. A record should be kept by the mine of each shipment to the smelter showing total quantities of metals, metals paid for, if the ore is purchased, or metals returnable for account of the shipper, if on toll, and charges, penalties, and premiums as provided for in the smelter contract, all of which should be reconciled with the agreed assay. The values recorded on the books of the mine should be on the basis of metals paid for or returnable, as, for instance, if a smelter contract on the toll basis provided that 95 per cent of the copper, 90 per cent of the silver, and 100 per cent of the gold was returnable, the sales of metal by the mine could not exceed those amounts and the cost of sale of the 95 per cent of returnable copper would, in effect, be increased by the cost of the 5 per cent of the copper not paid for.

The book in which ore settlements are entered may be used as a register to give totals of metals paid for or returnable, and smelting, reduction, and refining expense, as well as marketing commission where the contract is on a toll basis and the smelter acts as a marketing agent. If, however, marketing is in the hands of an agency separate from the smelter, these charges would be kept in a separate account.

When these records are completed we have a mining and milling cost per ton and sales of metals and smelting, reduction, and refining charges on a pound basis. We are now in a position to apply mining, milling, concentrating, and transportation costs to the units of metal produced. Though there will be no inventories of finished metals at the mine, it is not unusual to show finished metal on hand where ores and concentrates are treated on

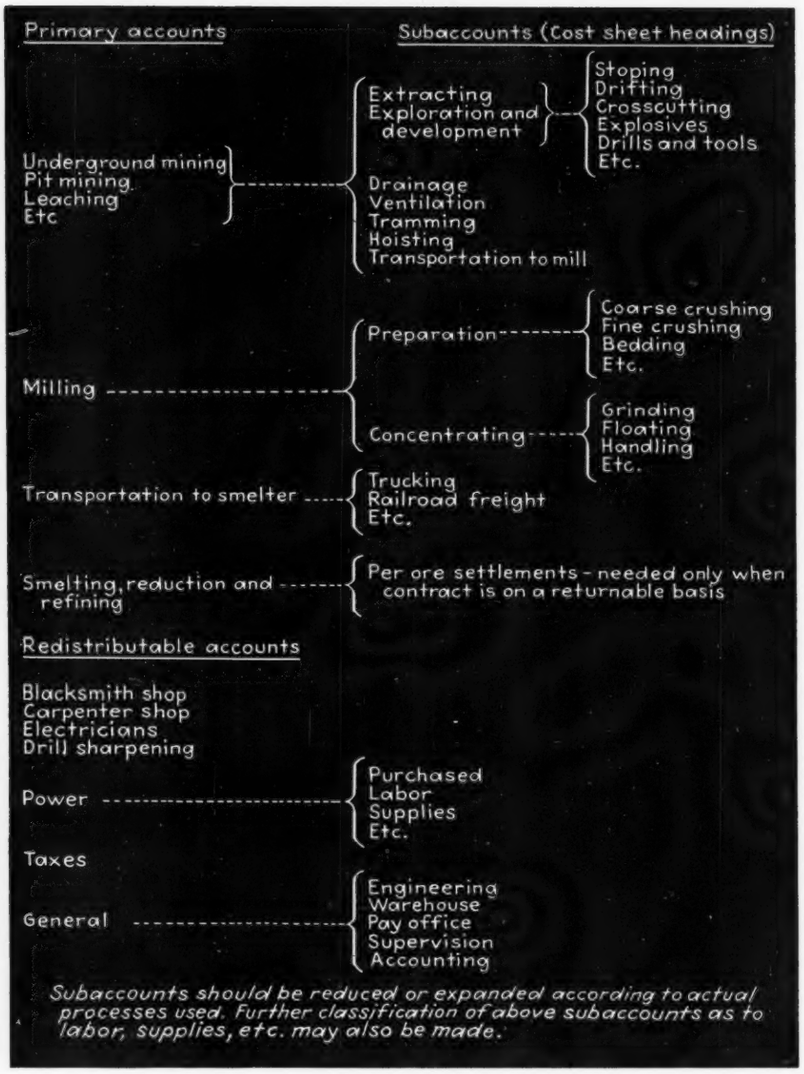


Chart of accounts for a small mining enterprise. Note the diagram on the opposite page

a toll basis and metals remain unsold at the end of a period. Metals in such inventories will be valued at cost where this is below market, and it should be remembered that the cost of the principal metal is reduced by the values of the precious or other subsidiary metals that may be produced with it.

Inventories of ore at a mine are seldom considerable in amount and, in many cases, mining, milling, and concentrating costs for a period are assumed to apply to shipments of that period. If, however, conditions require that a substantial inventory of ore be built up at particular times or seasons, then the total mining, milling, and concentrating costs may be reduced by the proportion of cost represented by ore inventories. This condition is generally brought about by particular mining methods, such as the shrinkage system where substantial quantities of broken ore will be on hand at all times; by transportation difficulties where, for instance, a mine might operate several months in the winter but be unable to ship ore, or a mine might be in some remote and inaccessible location where large quantities of ore had to be collected and shipped at long intervals. In any event, a cost of mining and concentrating for a definite period would be arrived at.

Depreciation is definitely a cost of mining operation even though it is not paid currently in cash. Probably the most satisfactory method of dealing with depreciation is to determine the tonnage which the mine and the mill plant are expected to produce and to charge depreciation accordingly. Obviously, some sort of estimate of ore reserves is required for this. Such an estimate should be on the small side, as this will insure the depreciation of the plant too early rather than too late. Such an estimate of ore reserves need not be complete or final and may be amended as conditions change. For copper, for instance, depreciation rates generally run from 0.75c. per pound to 1½c. It is not impossible that a rate might work out higher or lower than this range, but where this happens, the basic data should be inquired into, as it may indicate that these data are incorrect or it may point to abnormal features of the operation. Some properties, where the life or ore reserves cannot be estimated even approximately, must, of necessity, use a straight-line method, and here each month or year the total written off will be distributed to units produced.

The question of depletion has not been touched on. In many properties this is not considered in the financial accounts except for tax purposes and the amounts arrived at for tax purposes seldom have any necessary connection with current operating and financial conditions, as they are based either on valuations at some comparatively remote date or on more or less arbitrary percentages. Where depletion is taken into the accounts it is shown generally as a separate item in the Income and Surplus Accounts. Some writers on general accounting theory have stated that depletion may be considered as an inventory cost, but the practice of the industry and the views of the accountants of important mining enterprises and of practical mining men are overwhelmingly against this position.

It is impossible here to do more than indicate the special problems involved in mine accounting and it is impossible to attempt to cover any accounting questions common to both mining and various other types of industry.

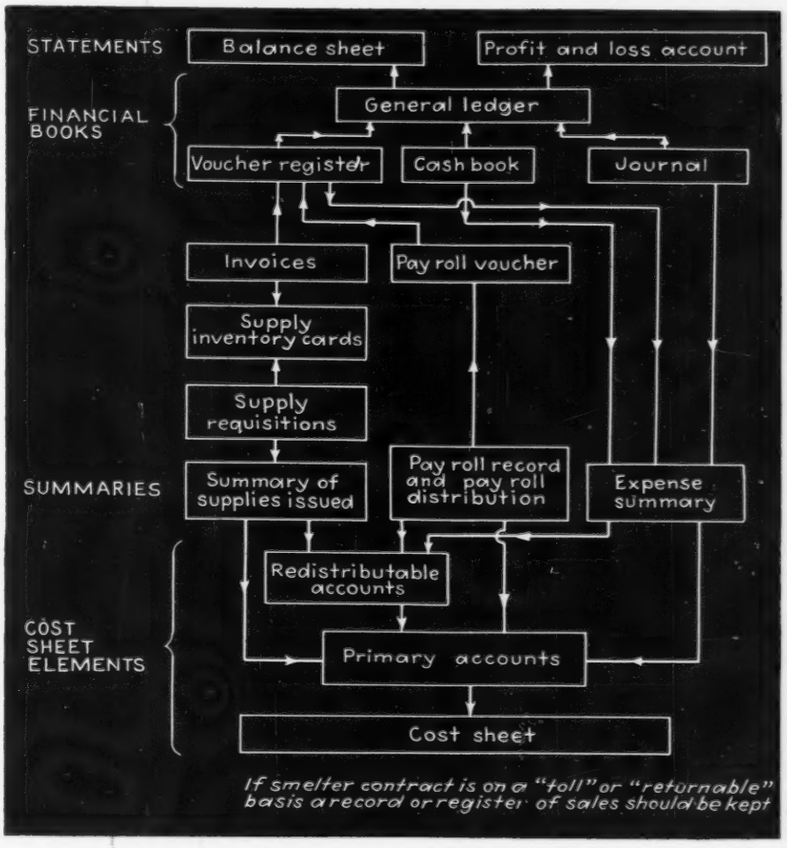
In mine accounting, particularly for a small operation, it is better to work with columnar distribution books and registers than with the conventional double-entry journals and ledgers. Conventional books must be used for control of the distribution and analysis books, but they are merely for the purpose of control and the columnar books should form the basic record. These columnar books are usually a classified pay-roll register, classified report of supplies issued, a distribution book for expenses, and summary books leading to the preparation of cost sheets.

A chart showing the interrelation of the various books and records with the cost sheet is shown as well as a simple classification of cost accounts.

The preparation of an accurate and informing cost sheet is the primary purpose of mine cost accounting. For a small operation, a mine manager is primarily interested in costs. If he knows these, he can generally calculate his profits mentally. Prompt and accurate cost figures are the basic requisite for efficient mine operation. Cost accounting for mining operations is simple. There are but three current elements to consider—wages, supplies, and expenses—and these must all be assigned eventually to the cost of the product and must enter into the unit cost.

Like every other set of accounting records, the accounts of a mine will be well and accurately kept if the final results to be attained are kept in mind from the beginning of the accounting work and if the man in charge of the accounts keeps continually before him the need of the management for information. He may even, in some circumstances, call attention to particular conditions which come to his notice through the accounts before such information is asked for by the management.

Accounts and records for a small mining enterprise arranged to show their relationship



The Small Operator Organizes

Recent years have seen this movement grow, with mutual welfare as an objective. Already in four mining States there are effective groups

Arthur L. Flagg
Consulting Mining Engineer
Phoenix, Ariz.

BORN of the depression has sprung a new movement in recent years that has for its objective the betterment of conditions for those independent mine owners and operators whose capital and efforts are being devoted to enterprises of small or modest size. Many circumstances have conspired against their welfare, evidenced by their decreasing numbers. Lacking influence individually, they were helpless where adverse legislation threatened. Under such conditions they have sought to organize in effective groups. This movement has not been limited to the United States. Mexico, for instance, has its counterpart with its *mineros en pequeño*, and even from Rhodesia, in Africa, comes news of the activities of the so-called "smallworkers" in their efforts to resist increasing taxes. In this country the best example of the movement and perhaps the best organized of any of these groups is to be found in the Arizona Small Mine Operators Association, which has its headquarters in the State capital, Phoenix. It has been selected for description in the following paragraphs as best typifying the movement.

When announcement was made that the Arizona Small Mine Operators Association had been organized not even the mining camps of the State gave it much thought; neither did it make front-page news for the daily papers. That was not contrary to the expectations of the sponsors, whose objective was constructive service. In common with many others they long had been aware of the handicap besetting the small mine owner and the prospector, both of whom are essential factors in the development of hitherto unprospected bits of the public domain, if such development is still possible. There is a considerable list of unsatisfactory conditions oppressive not only to individuals but distinctly obstructive to the progress of the mining industry as a whole. Because certain types of restraints have been increasing at a disconcerting rate in recent years, it was felt that the time had come to make a determined stand against further abuses and, if possible, apply some corrective measures. Hence the new Association.

The missionary work necessary to spread the idea was done by a field secretary who figuratively "beat the brush" to contact the small mine operator and the prospector, the latter often being found at the very end of the road, and a rather bad road at that. From the chief executive of a small operation boasting a steady daily production and a modest payroll down to the staunch individual who sharpens his own hand steel and hopefully presses on beyond the point where others, less courageous, are willing to carry on, went the secretary with his idea. Practically every person thus contacted became a ready convert. Response was beyond all expectation. In an incredibly short time, less than 60 days, 800 members had been enrolled. And since Feb. 1, 1938, up until June 1, 1940, the membership has increased to a total of 3,915 members. The most optimistic estimate of the maximum enrollment had been placed at about 2,000 members distributed in 40 councils. Also, the number of councils has been increased, by popular demand, to 55, while the hoped-for membership has been nearly doubled. The membership fee is only one dollar, which precludes any possible claim that the sponsors are just another set of racketeers.

It was soon demonstrated that the membership was sincere and militant —desperately militant on certain questions. That in itself was good, for it set this new group apart as different from the organization in which a small minority frames the policies and pulls the rest of the membership along, or, at the other extreme, those instances where the minority induces the unsuspecting majority to put over something which the former could not accomplish. The advantage to be gained from free discussion among all members was early stressed. And in the atmosphere of understanding which such discussion creates an effort has been made to study problems constructively rather than in a spirit of intolerance. This attitude has been an important factor in the successes achieved.

The organization follows a democratic plan which aims at unity of action based on an understanding of every phase of the problem under consideration. Then the majority rules. No one is excluded from membership. The only requisite is a serious interest in mining. Equal opportunity to be heard is given to all.

In the beginning the State was arbitrarily divided into 40 districts. The key community in each district was chosen as the meeting place and headquarters for the members in that section, who constituted an independent and autonomous council. Council meetings are held at convenient intervals and any pertinent problem may be presented by any member for discussion. Though the council is concerned primarily with local problems, it may unite with other councils in the same county for consideration of problems affecting the county. Finally, all councils may act together and so throw the weight of the entire membership into the contest over a single issue. Each council elects its own representative to the governing board.

Whatever the truth may be, every forward movement is stalked from the shadows by a whispering campaign. No one should wonder that many ulterior motives have been declared each to be the true objective of the Arizona organization or of its leaders. If any of the supposed objectives is definitely the goal, then the facts have been successfully concealed. It was intended by the plan of organization that no program known to be favorable to a group but distinctly harmful to mining in general could be successfully carried out. But no matter how sincere the majority in any group, it is impossible to prevent unsponsored and unsupported maneuvering within, if some are so inclined. Still, safety is thought to exist in numbers and in the rank and file sound thinking may prevail. It is not fantastic to hope that the small operators will maintain their loyalty to their group and at the same time be guided by the knowledge of what is right.

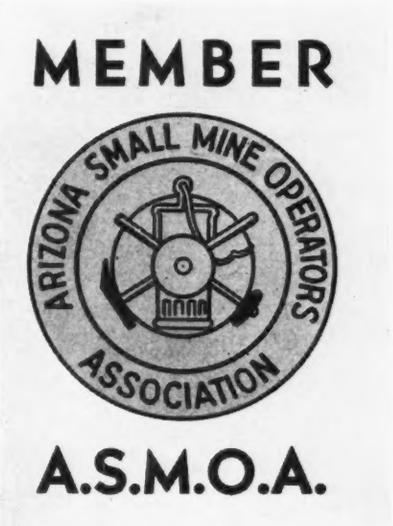
What does the organization propose to do? No charts are needed to convince the small operator that his position has been growing increasingly

hazardous. Those familiar with the mining industry in the State know the extent to which operations of moderate size have disappeared. This disappearance is not due to being swallowed up by larger organizations. It is the accumulation of restraints and penalties that has forced the small operator to withdraw. The same obstacles bar the way to the entrance of new capital into this field. One by one they have been thrown across the path of the small operator, but little could be done about it. It remained for the new organization to demonstrate what concerted effort can accomplish. Thus the potential advantages of a State-wide organization, made up of scattered units but having a central head, were quickly recognized, and the small operator has put his shoulder to the wheel. Confident in their new strength, the individual groups began to function, all headed for one objective, the preservation of the mining industry's rights. At the convening of the first council in Prescott in August, 1938, this marking the formal launching, the objective was tersely stated: "to foster and protect the mining industry of the State of Arizona particularly relating to the problems of the small operator."

Most of the man-made difficulties of the mining industry are regulations enacted by State or Federal bureaus. Much mining legislation originates in mining communities and is endorsed by at least a substantial number of people familiar with the problems of the industry. As a rule such regulations are the result of conscientious efforts to accomplish desirable objectives, but fail because of their proponents' lack of understanding of all the factors. Still other proposals, honestly made and beneficial to other industries, may be unfavorable to mining. A few have been made by small groups seeking special privileges. Finally others—and these are the most obnoxious—are just crackpot ideas fostered by individuals or groups which have either a hobby or a grudge. To correct abuses thus arising is the major objective of the Arizona organization.

The first battle resulted in a victory. The Association successfully opposed an increase in freight rates on ores and ore products. During the first six months of its existence thirteen problems were attacked. Ten of these affected all mining States; the remaining three were more or less Arizona problems. With respect to some of those of national scope the Association opposed a cut in the tariff on lead, zinc, and tungsten under the reciprocal trade agreements with Canada and Great Britain; it proposed an "averaging hours" amendment to the wages-and-hours bill; it opposed the withdrawal of public lands; it initiated agitation for considering silver with a view to getting a higher price; it launched a movement for a higher price for gold to small producers (some were receiving only $16 per ounce); it started agitation for use of copper in Government construction programs; it opposed taxes on fuel oil and the repeal of the copper excise tax. The subject of all classes of R.F.C. mining loans has likewise come in for its share of discussion. Early this year the Association sponsored a bill in Congress, to provide a new type of mine loan known as Class C.

The Arizona association took the lead in an effort to coordinate all of the 55 State mining organizations in the West. This is being accomplished by meetings of the secretaries. The first was held in Los Angeles in October, 1938; the following year the meeting was in Salt Lake City. In September of this year it will be in Colorado Springs. Interchange of ideas between secretaries, particularly with respect to purely local problems, is of greater value than at first might be suspected. Because there is a degree of similarity in the questions which come up, the experience in one State is of value to others who are approaching the same or similar problems. The principal function, however, is to unify the efforts of widely scattered forces, for the benefit of all mining States in matters pertaining to national legislation affecting mining.



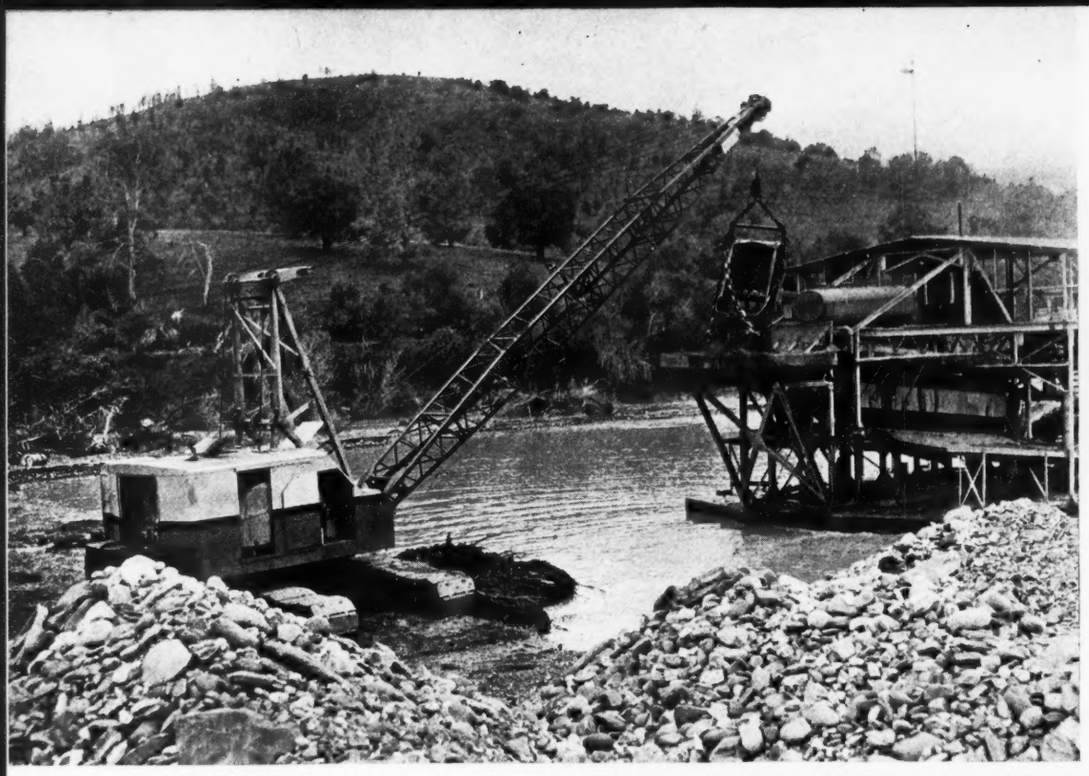
The A.S.M.O.A. provides its members with windshield stickers for their cars

At the first meeting of the State Council in Prescott in 1938 a resolution was passed which called for a complete study of State Land Office procedure respecting mineral lands. The citation of certain abuses speedily secured much needed revision of practices and an elimination of unjust discrimination against mines. Another problem strictly of Arizona that was successfully handled was that of certain adjustments of the industrial insurance program.

Before the Association was a year old the fourteenth session of the Arizona State Legislature opened. Hardly had the excitement of the November elections subsided when the Association made a clear-cut declaration of its policy, announcing its intention to oppose oppressive legislation and to cooperate in all efforts to secure the passage of any constructive legislation. As a result, not one of the large number of definitely harmful bills submitted passed even the lower house. The outstanding accomplishment of the session, from the Association's viewpoint, was the passage of a bill creating a State-supported Department of Mineral Resources, the function of which is to render all service possible to small mine operators. Through a corps of field engineers, who make frequent contacts with operations throughout the State, the particular economic problems of each district can be presented to the Department for study. Assistance in bringing in new capital for mining development has been stressed as an important function of the department.

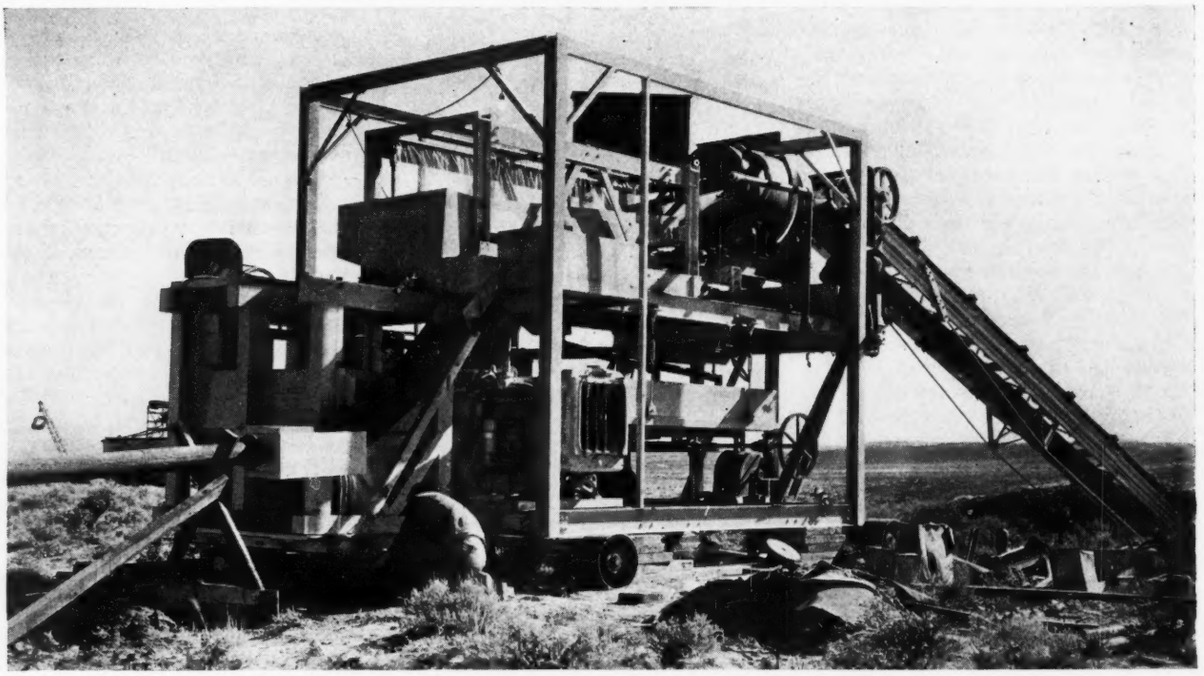
The bill was opposed vigorously on the ground that the operation of the new department would increase the taxes. From other sources it was opposed on the ground that it would duplicate or overlap well-established agencies, such as the Arizona Bureau of Mines; that its field representatives would be in preferred position and so in competition with registered engineers carrying on private practice in the State; that it could not be operated as a clearing house between property owners and prospective investors without prejudice, and so on. Despite these arguments, and many more, its passage was secured and the Department has been operating for a year. It points out that during this period it has been directly responsible for the initiation of twenty new mining projects within the State, having an estimated monthly payroll of perhaps $50,000. New taxes to be paid by them will exceed the operating cost of the Department.

It is conceded that this particular Association has proved its worth. Its record viewed from outside the State by interested observers who have some of the same problems to cope with has led to the adoption of identical plans of operation by similar organizations in Washington, Oregon, and New Mexico. Continued success depends upon cooperation and careful weighing of every problem with respect to the greatest good for the greatest number. None the less important is the careful avoidance of any movement which, regardless of its intent, might be branded "politics."



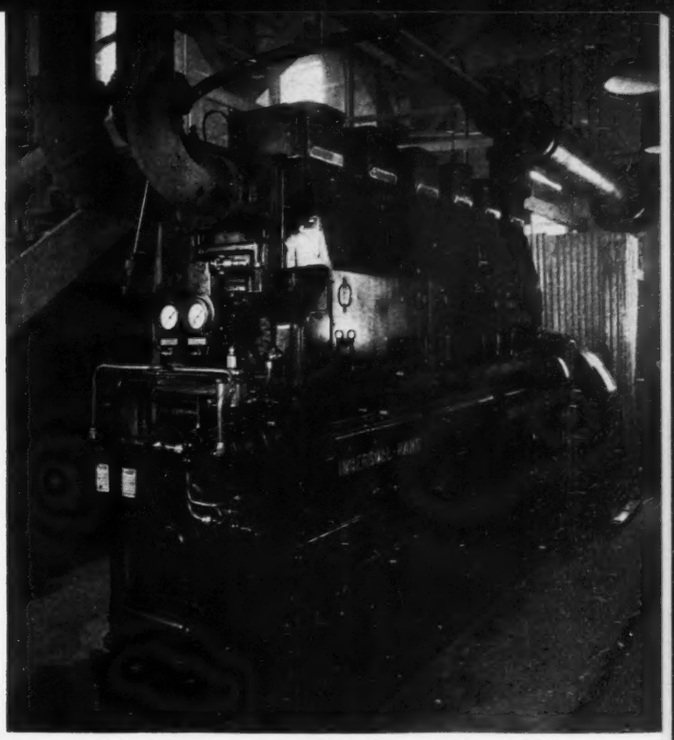
At the placer operation of Lord & Bishop, near Valley Springs, Calif., a Marion 3-yd. dragline is powered by a 200-hp. 6-cyl. Cummins diesel engine. Fuel consumption on 24-hr. operation is 4 to 5 gal. per hr.

Craig, Colo., is the site of this placer operation in which a Caterpillar diesel-electric generator supplies power to dredge and to recovery plant consisting of mixer, conveyor, jig, amalgamator, pump, and other equipment

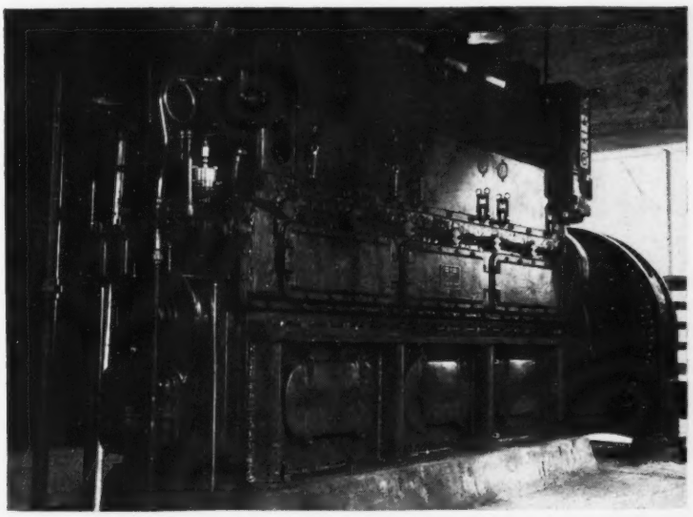


Mack tractor and semi-trailer equipped with 150-hp. Cummins diesel hauls tailings to C. Y. Semple Mining Co., Baxter Springs, Kan. Round trip, 4 mi., 20 min. Fuel consumption 15 to 20 gal. per 8-hr. shift

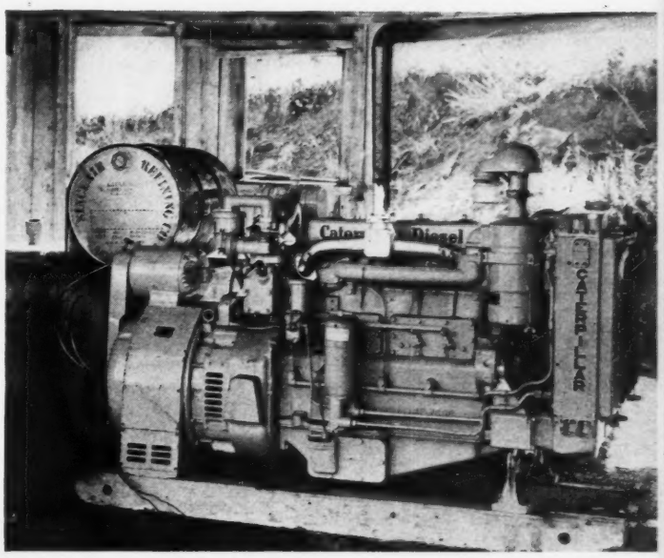
Power for the Small Mine



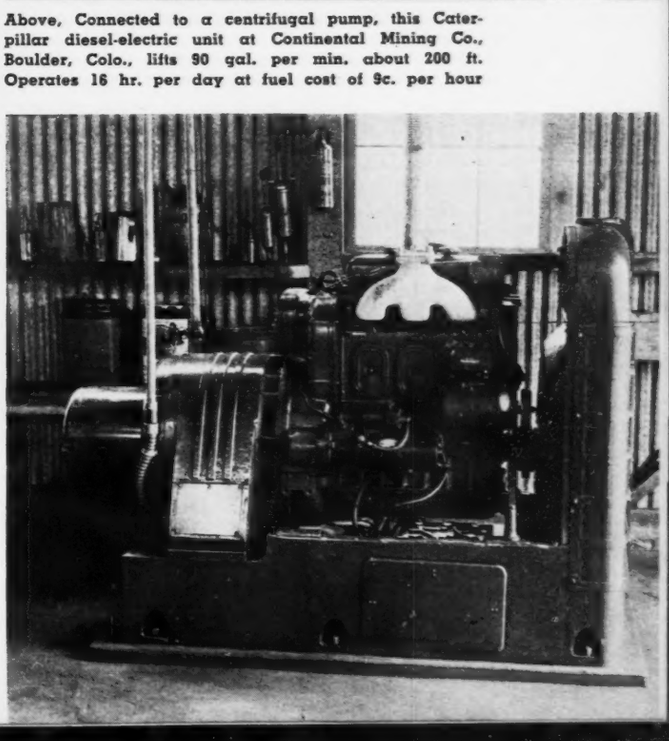
Cornucopia Gold Mines, Cornucopia, Oregon, has three sources of power, one of which is this 6-cyl. Ingersoll-Rand diesel. Over 3-yr. period the unit generated 10.5 kw.-hr. per gal. of fuel oil



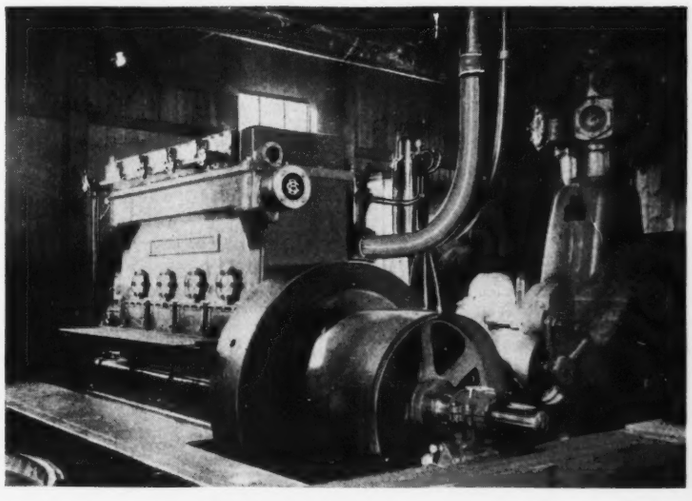
Total power requirements for Creede Mills, Creede, Colo., handling 125 tons of ore per day, are provided by this 6-cyl. Ingersoll-Rand diesel rated at 175 kw. The unit develops 12.9 kw.-hr. per gal. fuel oil



At the Kenricia Gold Mines, Ltd., near Kenora, Ont., Canada, a Dominion-Crossley 4-cyl. diesel engine of 200 b.hp. drives a Canadian Ingersoll-Rand air compressor



Above, Connected to a centrifugal pump, this Caterpillar diesel-electric unit at Continental Mining Co., Boulder, Colo., lifts 90 gal. per min. about 200 ft. Operates 16 hr. per day at fuel cost of 9c. per hour



Right, Power used at mine, mill, and camp of Bondurant Mining & Milling Co., Coulterville, Calif., is obtained from three General Motors diesel-generator sets. Fuel cost for all units, 40.5c. per hr. Ore production 30 ton per day

MONTHLY COMMENT • DAILY AND AVERAGE MONTHLY

Summary of the

MARKETS

DELIVERIES of major non-ferrous metals to fabricating plants were large during July, pointing to a high rate of general activity. The huge defense program, plus a steady flow of export business for account of Great Britain, are expected to lift consumption of metals over the remainder of the year. The operating rate of the steel industry increased to 90 per cent of capacity.

Monthly averages for copper, silver, and tin were lower, with the result that the *E.&M.J.* index of prices for July was 76.72, against 78.85 in June. However, both copper and tin closed the month at a small net gain so far as daily quotations were concerned.

Buyers of copper were reserved over the first half of the month, owing to weakness in foreign metal. The domestic quotation dropped to 10½c., Valley, at which level some good orders came into the market, strengthening prices. On the last day of July 11¼c. was asked by custom smelters and small producers. The large mine operators held to 11½c., Valley, all month. Domestic sales for July totaled 58,623 tons, against 110,454 tons in June. Japan was the only tonnage buyer of copper in the export field. The narrow market for foreign metal caused the export price to decline to 9.90c., f.a.s. New York.

Excellent domestic lead statistics failed to excite the market because of the threat of imports. The quotation was unchanged.

Uncertainty about foreign developments caused the price of zinc to hold at 6¼c., St. Louis, in spite of active buying and small stocks.

So far, the Government has purchased about 3,000 tons of tin for its 75,000-ton stockpile. The price strengthened late in July on apprehension over Japan. Deliveries of primary tin in the United States in the first half of 1940 amounted to 50,509 tons, against 30,000 tons in the same period last year.

UNITED STATES MARKET

1940	Electrolytic Copper		Straits Tin	Lead		Zinc
July	Domestic (a) Refinery	Export (b) Refinery	New York	New York	St. Louis	St. Louis
1	10.775@10.900	10.650	52.250	5.00	4.85	6.25
2	10.725	10.650	52.250	5.00	4.85	6.25
3	10.650@10.775	10.600	52.000	5.00	4.85	6.25
4	Holiday	10.450	Holiday	Holiday	Holiday	Holiday
5	10.675	10.450	52.000	5.00	4.85	6.25
6	10.525@10.650	10.450	52.000	5.00	4.85	6.25
8	10.525@10.650	10.450	52.000	5.00	4.85	6.25
9	10.550	10.400	51.500	5.00	4.85	6.25
10	10.650	10.400	51.500	5.00	4.85	6.25
11	10.650	10.275	51.375	5.00	4.85	6.25
12	10.650	10.250	51.250	5.00	4.85	6.25
13	10.650	10.250	51.250	5.00	4.85	6.25
15	10.525@10.650	10.200	51.250	5.00	4.85	6.25
16	10.525	10.200	51.000	5.00	4.85	6.25
17	10.525	10.200	51.000	5.00	4.85	6.25
18	10.400@10.525	10.000	51.000	5.00	4.85	6.25
19	10.400@10.525	10.050	51.000	5.00	4.85	6.25
20	10.400@10.525	10.050	51.000	5.00	4.85	6.25
22	10.275@10.400	10.025	51.000	5.00	4.85	6.25
23	10.275	9.950	51.250	5.00	4.85	6.25
24	10.275	9.950	51.375	5.00	4.85	6.25
25	10.275	9.900	51.500	5.00	4.85	6.25
26	10.400	9.875	51.625	5.00	4.85	6.25
27	10.425	9.875	51.625	5.00	4.85	6.25
29	10.575	9.850	52.000	5.00	4.85	6.25
30	10.775	9.850	52.500	5.00	4.85	6.25
31	11.025	9.850	52.875	5.00	4.85	6.25
			AVERAGES FOR MONTH			
July	10.564	10.189	51.591	5.000	4.850	6.250
			AVERAGES FOR WEEK			
July 3	10.788	10.692	52.450	5.000	4.850	6.250
10	10.610	10.433	51.800	5.000	4.850	6.250
17	10.598	10.229	51.188	5.000	4.850	6.250
24	10.379	10.004	51.104	5.000	4.850	6.250
31	10.579	9.867	52.021	5.000	4.850	6.250
			CALENDAR WEEK AVERAGES			
July 6	10.708	10.542	52.100	5.000	4.850	6.250
13	10.623	10.338	51.479	5.000	4.850	6.250
20	10.504	10.117	51.042	5.000	4.850	6.250
27	10.331	9.929	51.396	5.000	4.850	6.250

SILVER, GOLD AND STERLING EXCHANGE

1940	Sterling Exchange		Silver		Gold	
July	"Checks"	"90-day demand"	(c) New York	London	London	(d) United States
1	377.0000	(f)	34.750	21.6875	168s	$35.00
2	380.0000	(f)	34.750	21.8125	168s	35.00
3	382.0000	(f)	34.750	21.7500	168s	35.00
4	Holiday	Holiday	Holiday	21.7500	168s	Holiday
5	378.0000	(f)	34.750	21.6875	168s	35.00
6	376.0000	(f)	(e)	(e)	(e)	35.00
8	372.5000	(f)	34.750	21.6875	168s	35.00
9	374.0000	(f)	34.750	21.6875	168s	35.00
10	375.0000	(f)	34.750	21.9375	168s	35.00
11	370.0000	(f)	34.750	21.8125	168s	35.00
12	366.0000	(f)	34.750	21.7500	163s	35.00
13	370.0000	(f)	(e)	(e)	(e)	35.00
15	385.0000	(f)	34.750	22.0625	168s	35.00
16	382.0000	(f)	34.750	22.1875	168s	35.00
17	373.0000	(f)	34.750	22.3750	168s	35.00
18	386.0000	(f)	34.750	22.5000	168s	35.00
19	382.0000	(f)	34.750	22.6250	168s	35.00
20	389.0000	(f)	(e)	(e)	(e)	35.00
22	387.0000	(f)	34.750	22.1875	168s	35.00
23	378.0000	(f)	34.750	22.4375	168s	35.00
24	385.0000	(f)	34.750	22.3750	168s	35.00
25	388.0000	(f)	34.750	22.1875	168s	35.00
26	384.0000	(f)	34.750	22.3750	168s	35.00
27	385.0000	(f)	(e)	(e)	(e)	35.00
29	386.0000	(f)	34.750	22.5625	168s	35.00
30	383.0000	(f)	34.750	22.3750	168s	35.00
31	380.0000	(f)	34.750	22.3750	168s	35.00
			AVERAGE FOR MONTH			
July	379.750	.....	34.750	22.095	.....	35.00
			AVERAGES FOR WEEK			
July 3	382.833	.....	34.750	.....	.....	.....
10	375.100	.....	34.750	.....	.....	.....
17	374.333	.....	34.750	.....	.....	.....
24	384.500	.....	34.750	.....	.....	.....
31	384.333	.....	34.750	.....	.....	.....

Calendar week averages, New York Silver: July 6th, 34.750; 13th, 34.750; 20th, 34.750; 27th, 34.750.

(e) Not quoted (Saturday). (f) No quotations.

THE above quotations for major non-ferrous metals are our appraisal of the important United States markets, based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

(a) Net prices at refineries on Atlantic seaboard. To arrive at the delivered New England basis add 0.225c. per pound, the average differential for freight and delivery charges.

(b) Export prices are net at refineries on the Atlantic seaboard and include sales of domestic copper in the foreign market. Owing to the European War and the disruption of normal trade relations, our export copper quotations, since September, 1939, have been based largely on f.a.s. transactions, ex United States ports. To arrive at the f.o.b. refinery quotation deduct .05 from the f.a.s. basis for lighterage.

Copper, lead and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

Quotations for copper are for the ordinary forms of wirebars and ingot bars; cathodes are sold at a discount of 0.125c.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York commands a premium over the St. Louis basis equal to the freight differential. Contract prices for High Grade zinc delivered in the East and Middle West in nearly all instances command a premium of 1c per pound over the current market for Prime Western but not less than 1c over the *Engineering and Mining Journal's* average quotation for Prime Western for the previous month.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

(c) Silver other than newly-mined domestic, by Handy & Harman. Under Treasury order of July 6, 1939, the price on domestic newly-mined silver mined subsequent to July 1, 1939, was fixed at 71.11c per troy ounce. Handy & Harman's quotation on newly-mined domestic silver, 999 fine was 70⅝c throughout July.

(d) U. S. Treasury's gold price. Actual payment by the United States Treasury for gold in domestic and imported ore or concentrate is at 99.75 per cent of the price quoted by the Treasury, which at present is equal to $34.9125.

PRICES OF METALS • MISCELLANEOUS QUOTATIONS

LONDON MARKET

1940 July	COPPER Standard Spot	COPPER Standard 3 months	COPPER Electro Bid	TIN Standard Spot	TIN Standard 3 months	LEAD Spot Buyers	LEAD Spot Sellers	LEAD 3 months Buyers	LEAD 3 months Sellers	ZINC Spot Buyers	ZINC Spot Sellers	ZINC 3 months Buyers	ZINC 3 months Sellers
1	Not quoted			257.5000	260.2500	Not quoted							
2	"	"	"	262.7500	265.2500	"	"	"	"	"	"	"	"
3	"	"	"	265.2500	266.2500	"	"	"	"	"	"	"	"
4	"	"	"	265.5000	265.5000	"	"	"	"	"	"	"	"
5	"	"	"	266.0000	266.2500	"	"	"	"	"	"	"	"
8	"	"	"	264.2500	264.2500	"	"	"	"	"	"	"	"
9	"	"	"	263.2500	263.2500	"	"	"	"	"	"	"	"
10	"	"	"	264.7500	264.0000	"	"	"	"	"	"	"	"
11	"	"	"	267.5000	266.2500	"	"	"	"	"	"	"	"
12	"	"	"	266.1250	265.2500	"	"	"	"	"	"	"	"
15	"	"	"	265.2500	264.2500	"	"	"	"	"	"	"	"
16	"	"	"	265.0000	264.0000	"	"	"	"	"	"	"	"
17	"	"	"	264.7500	264.2500	"	"	"	"	"	"	"	"
18	"	"	"	266.5000	265.0000	"	"	"	"	"	"	"	"
19	"	"	"	265.7500	264.5000	"	"	"	"	"	"	"	"
22	"	"	"	266.5000	265.5000	"	"	"	"	"	"	"	"
23	"	"	"	267.0000	266.0000	"	"	"	"	"	"	"	"
24	"	"	"	266.7500	266.5000	"	"	"	"	"	"	"	"
25	"	"	"	266.7500	266.7500	"	"	"	"	"	"	"	"
26	"	"	"	266.2500	266.0000	"	"	"	"	"	"	"	"
29	"	"	"	267.7500	267.0000	"	"	"	"	"	"	"	"
30	"	"	"	268.5000	268.0000	"	"	"	"	"	"	"	"
31	"	"	"	269.0000	268.5000	"	"	"	"	"	"	"	"
Average for month...				265.592									

Prices for tin are the official prices of the London Metal Exchange, in long tons (2240 lb.). Trading in other metals remained suspended.

CURRENT PRICES — MISCELLANEOUS METALS, ORES, AND NON-METALLIC MINERALS

Quotations cover wholesale lots, prompt shipment, f.o.b. New York, unless otherwise stated

(Aug. 1, 1940)

MISCELLANEOUS METALS

Aluminum, ingot, 99 plus per cent, lb	18c.
Antimony, domestic, spot, lb	14.00c.
Bismuth, ton lots, lb	$1.25
Cadmium, commercial sticks, lb	80c.
Calcium, lb., ton lots 97 @ 98 per cent	Nominal
Chromium, 97 per cent grade, lb	89c.
Cobalt, 97 to 99 per cent, per lb	$1.50
Nickel, electrolytic cathodes, lb	35c.
Magnesium, 99.8 per cent, carloads, lb	27c.
Palladium, troy oz	$24.00
Platinum, (Official quotation) troy oz	$38.00
Quicksilver, flask of 76 lb., 100 flasks or more	$188.00
Radium, mg. radium content	$25.00@$30.00
Selenium, 99.5 per cent, lb	$1.75
Silicon, minimum 97 per cent, spot, lb	16.50c.
Tellurium, lb	$1.75
Thallium, 100 lb. or more, lb	$6.50
Titanium, 96 to 98 per cent, lb	$5.00

METALLIC ORES

Beryllium Ore, f.o.b. mines, ton	$30.00@$35.00
Chrome Ore, 48 @ 50% Cr_2O_3 c.i.f. Atl. ports, long ton	(b)$26.00@$30.00
Iron Ore, Lake Superior, Lower Lake ports, long ton:	
Old Range bessemer	$4.75
Mesabi bessemer	$4.60
Old Range non-bessemer	$4.60
Mesabi, non-bessemer	$4.45
Lead (Galena) 80 per cent, Joplin, Mo., ton	$57.34
Manganese Ore, (foreign) c.i.f. U.S. ports, long ton unit of Mn:	
52 @ 55 per cent	(b) 55c.
50 @ 52 per cent	(b) 55c.
46 @ 48 per cent	(b) 48@52c.
Molybdenum Ore, 90%, per lb. of MoS_2, f.o.b. mines	45c.
Tungsten Ore, per unit of WO_3:	
Chinese, 65 per cent, duty paid	$23.50
Domestic, 65 per cent and upward	(a)$22.00@$23.00
Vanadium Ore, per lb. of contained V_2O_5	27½c.
Zinc Ore, Prime, 60 per cent concentrate, Joplin, Mo.; per ton	$41.00

(a) Prices at mines, small lots, usually several dollars less. (b) Nominal.

METALLIC COMPOUNDS

Arsenious Oxide (arsenic) lb	3¼c.
Cobalt Oxide, 70 @ 71 per cent, lb	$1.84
Copper Sulphate, 100 lb	$4.60
Sodium Nitrate, ex vessel, in 200-lb. bags, per 100 lb	$1.42
Sodium Sulphate, bulk ton	$13.00@$15.00

ALLOYS

Berryllium Copper, master alloy, 2.5 to 3 per cent Be, per lb. of contained Be	$15.00
Ferrochrome, 65 @ 70 per cent chromium, 4 @ 6 per cent carbon, lb	11c.
Ferromanganese, 78 @ 82 per cent, gross ton	$120.00
Ferromolybdenum, 55 @ 65 per cent Mo. lb. of Mo. contained	95c.
Ferrosilicon, 50 per cent, gross ton	$74.50
Ferrotungsten, 75 @ 80 per cent, lb. of W contained	$1.90@$2.00

NON-METALLIC MINERALS

Asbestos, f.o.b. mines, ton:	
Canadian (Quebec)	
Crude No. 1	$700@$750
Crude No. 2	$150@$350
Spinning fibers	$110@$200
Paper stock	$40@$45
Shorts	$12@$16.50
Vermont	
Shingle stock	$57
Paper stock	$40
Cement stock	$25
Barytes, long ton:	
Georgia, crude	$7.00
Missouri, 93 per cent $BaSO_4$, less than 1 per cent iron	$6.00@$6.50
Bauxite, long ton:	
Domestic, chemical, 55 @ 58 per cent	$6.00@$7.00
Domestic, abrasive, 80 @ 84 per cent	$13.00@$14.00
Dalmatian, 50 @ 55 per cent	Nominal
French, 56 @ 59 per cent	Nominal
China Clay, f.o.b. mines, ton:	
South Carolina and Georgia, No. 1, bulk	$6.75@$8.00
Delaware, No. 1	$14.50
Feldspar, bulk, ton:	
Potash feldspar, 200 mesh	$17.00
Glass-spar, white, 20 mesh	$11.75
Fluorspar, f.o.b. mines, bulk, Kentucky and Illinois 85–5 per cent, all rail movement, ton	$20.00
Fuller's earth, f.o.b. Georgia or Florida, ton	$7.00@$14.00
Magnesite, per ton:	
Dead-burned, f.o.b. California	$25.00
Dead-burned, f.o.b. Washington	$22.00
Mica, per lb., North Carolina, No. 1 and 2 quality:	
1½ x 2 in.	45@60c.
2 x 2 in.	60@80c.
3 x 3 in.	$1.25@$1.50
3 x 4 in.	$1.50@$1.75
3 x 5 in.	$2.00@$2.50
White, ground, 70 mesh, ton	$60.00@$80.00
Ocher, Georgia, ton	$19.00@$22.00
Pyrites, Spanish, per long ton unit of S, c.i.f. Atlantic ports	(a) 12c.
Silica, in bags, 325 mesh, ton	$20.00@$40.00
Sulphur, Texas, mines, long ton	$16.00
Talc, f.o.b. works, ton:	
New York, double air-floated, 325 mesh	$12.00@$15.00
New Jersey, mineral pulp	$8.00@$10.00
Vermont, extra white, 200 mesh	$9.00@ $9.50
Tripoli, Missouri, ton:	
40 mesh, cream colored	$14.50
200 mesh, cream colored	$26.00

(a) Nominal

IRON AND STEEL

Pig Iron, Valley furnaces, gross ton:	
Bessemer	$23.50
Basic	$22.50
No. 2 Foundry	$23.00
Steel, base prices, Pittsburgh:	
Billets, gross ton	$34.00
Structural shapes, 100 lb	$2.10
Bars, 100 lb	$2.15

Monthly and Yearly

AVERAGE PRICES

SILVER AND STERLING EXCHANGE

	New York		London Spot		Sterling Exchange	
	1939	1940	1939	1940	1939	1940
January	42.750	34.750	20.305	21.892	466.775	395.442
February	42.750	34.750	20.370	20.935	468.472	395.652
March	42.750	34.750	20.280	20.763	468.370	375.212
April	42.750	34.750	20.031	20.713	467.778	351.817
May	42.750	34.949	20.123	21.878	467.988	326.452
June	41.955	34.825	19.505	22.688	468.137	359.560
July	34.944	34.750	16.952	22.095	468.031	379.750
August	35.951	.....	17.719	.....	460.383	.....
September	36.956	.....	22.178	.....	398.820	.....
October	35.726	.....	22.736	.....	400.350	.....
November	34.750	.....	23.378	.....	391.457	.....
December	34.956	.....	23.263	.....	391.830	.....
Year	39.082	.....	20.570	.....	443.199	.....

New York quotations for silver other than newly-mined domestic, cents per ounce troy, 999 fine, London pence per ounce sterling silver 925 fine. Sterling exchange (pound sterling) in cents.

COPPER

	F.O.B. Refinery, Electrolytic				London Spot			
	Domestic		Export		Standard		(a) Electrolytic	
	1939	1940	1939	1940	1939	1940	1939	1940
January	11.025	11.954	9.912	11.999	43.125	(b)	48.440	(b)
February	11.025	11.148	9.735	11.471	42.188	(b)	47.375	(b)
March	11.025	11.160	9.888	11.407	42 938	(b)	48.120	(b)
April	10.265	11.087	9.820	11.258	42.031	(b)	47.833	(b)
May	9.833	11.079	9.738	11.191	41.656	(b)	47.528	(b)
June	9.775	11.128	9.738	11.216	41.986	(b)	47.528	(b)
July	9.976	10.564	9.944	10.189	42.899	(b)	48.863	(b)
August	10.261	.....	10.211	.....	44.685	.....	50.409	.....
September	11.635	.....	11.685	.....	(b)	.....	(b)	.....
October	12.215	.....	12.491	.....	(b)	.....	(b)	.....
November	12.275	.....	12.929	.....	(b)	.....	(b)	.....
December	12.275	.....	12.631	.....	(b)	.....	(b)	.....
Year	10.965	.....	10.727	.....	(c) 42.689	.....	(c) 48.262	.....

New York quotations, cents per pound. London, pounds sterling per long ton, (a) Bid quotations. (b) No quotations. (c) Average for eight months.

LEAD

	New York		St. Louis		London			
	1939	1940	1939	1940	1939 Spot	1939 3 mos.	1940 Spot	1940 3 mos.
January	4.826	5.471	4.676	5.321	14.534	14.744	(a)	(a)
February	4.805	5.076	4.655	4.926	14.283	14.417	(a)	(a)
March	4.824	5.192	4.674	5.042	14.660	14.860	(a)	(a)
April	4.782	5.071	4.632	4.921	14.337	14.533	(a)	(a)
May	4.750	5.015	4.600	4.865	14.483	14.679	(a)	(a)
June	4.800	5.000	4.650	4.850	14.564	14.651	(a)	(a)
July	4.854	5.000	4.704	4.850	14.753	14.856	(a)	(a)
August	5.043	.....	4.893	.....	16.040	15.885	.....	.....
September	5.449	.....	5.299	.....	(a)	(a)	.....	.....
October	5.500	.....	5.350	.....	(a)	(a)	.....	.....
November	5.500	.....	5.350	.....	(a)	(a)	.....	.....
December	5.500	.....	5.350	.....	(a)	(a)	.....	.....
Year	5.053	.....	4.903	.....	(b) 14.707	(b) 14.828	.....	.....

New York and St. Louis quotations, cents per pound. London pounds sterling per long ton. (a) No quotations. (b) Average for eight months.

TIN

	Straits New York		Standard, Spot London	
	1939	1940	1939	1940
January	46.404	46.707	215.435	240.716
February	45.640	45.851	213.906	242.833
March	46.213	47.079	215.375	251.711
April	47.160	46.815	218.389	252.080
May	49.031	51.570	225.591	264.098
June	48.853	54.618	227.511	273.438
July	48.548	51.591	229.833	265.592
August	48.793	.....	229.869	.....
September	64.588	.....	229.292	.....
October	55.580	.....	229.943	.....
November	52.322	.....	230.000	.....
December	50.740	.....	248.974	.....
Year	50.323	.....	226.177	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

ZINC

	St. Louis		London			
	1939	1940	1939 Spot	1939 3 mos.	1940 Spot	1940 3 mos.
January	4.500	5.644	13.682	13.887	(a)	(a)
February	4.500	5.534	13.522	13.780	(a)	(a)
March	4.500	5.750	13.728	13.961	(a)	(a)
April	4.500	5.750	13.443	13.637	(a)	(a)
May	4.500	5.803	13.717	13.938	(a)	(a)
June	4.500	6.235	14.023	14.223	(a)	(a)
July	4.516	6.250	14.235	14.435	(a)	(a)
August	4.719	.....	14.628	14.761	.....	.....
September	6.104	.....	(a)	(a)	.....	.....
October	6.500	.....	(a)	(a)	.....	.....
November	6.500	.....	(a)	(a)	.....	.....
December	5.980	.....	(a)	(a)	.....	.....
Year	5.110	.....	(b) 13.872	(b) 14.078	.....	.....

St. Louis quotations, Prime Western, cents per pound. London, pound sterling per long ton. (a) No quotations. (b) Average for eight months.

CADMIUM AND ALUMINUM

	Cadmium		Aluminum	
	1939 (a)	1940 (a)	1939	1940
January	58.400	79.038	20.000	20.000
February	55.000	80.000	20.000	20.000
March	54.259	80.000	20.000	19.769
April	50.000	80.000	20.000	19.000
May	50.000	80.000	20.000	19.000
June	50.000	80.000	20.000	19.000
July	50.000	80.000	20.000	19.000
August	53.704	.....	20.000	.....
September	64.200	.....	20.000	.....
October	74.600	.....	20.000	.....
November	75.000	.....	20.000	.....
December	75.000	.....	20.000	.....
Year	59.180	.....	20.000	.....

Aluminum in cents per pound, 99 plus per cent grade. Cadmium, cents per pound. (a) Producers' price, commercial sticks.

ANTIMONY, QUICKSILVER, AND PLATINUM

	Antimony (a) New York		Quicksilver (b) New York		Platinum (c) New York	
	1939	1940	1939	1940	1939	1940
January	11.670	14.000	77.440	156.962	34.440	40.000
February	11.250	14.000	85.227	178.000	35.000	40.000
March	11.269	14.000	87.278	180.921	35.000	40.000
April	11.500	14.000	90.800	173.538	35.000	38.923
May	11.712	14.000	86.769	181.538	35.000	38.000
June	12.000	14.000	86.615	197.360	35.000	38.000
July	12.000	14.000	86.960	194.423	35.000	38.000
August	12.000	.....	84.407	.....	35.333	.....
September	12.910	.....	140.000	.....	40.080	.....
October	14.000	.....	145.600	.....	41.120	.....
November	14.000	.....	134.978	.....	40.000	.....
December	14.000	.....	141.200	.....	40.000	.....
Year	12.359	.....	103.940	.....	36.748	.....

(a) Antimony, cents per pound, ordinary brands, in cases; in bulk 13.415 for May. (b) Quicksilver, dollars per flask of 76 lb. (c) Platinum, dollars per ounce troy.

PIG IRON

	Bessemer		Basic		No. 2 Foundry	
	1939	1940	1939	1940	1939	1940
January	21.50	23.50	20.50	22.50	21.00	23.00
February	21.50	23.50	20.50	22.50	21.00	23.00
March	21.50	23.50	20.50	22.50	21.00	23.00
April	21.50	23.50	20.50	22.50	21.00	23.00
May	21.50	23.50	20.50	22.50	21.00	23.00
June	21.50	23.50	20.50	22.50	21.00	23.00
July	21.50	23.50	20.50	22.50	21.00	23.00
August	21.50	.....	20.50	.....	21.00	.....
September	22.50	.....	21.50	.....	22.00	.....
October	23.50	.....	22.50	.....	23.00	.....
November	23.50	.....	22.50	.....	23.00	.....
December	23.50	.....	22.50	.....	23.00	.....
Year	22.083	.....	21.083	.....	21.583	.....

Iron, dollars per long ton. F.o.b. Mahoning and Chenango Valley furnaces.

U. S. Foreign Trade Active in Minerals and Mining Machinery

Vital tradeways still open for export of mining machinery and import of minerals needed for national defense. Europe a minor factor. Western Hemisphere and rest of world much more important to United States

DESPITE the dislocation of international commerce and trade caused by the war in Europe, many of the tradeways of importance to the United States still remain open. This is particularly true with respect to imports of strategic and critical metals and minerals, and exports of mining, milling, and metallurgical machinery. Strangely enough Europe, which has been in the throes of war, has been neither an important supplier of these metals and minerals to the United States, nor a major buyer of American mining machinery. Most of our foreign trade in these lines has been with other parts of the world that are still open to American commerce.

Examination of the statistics of the Bureau of Mines and the Bureau of Foreign and Domestic Commerce for 1939 and the early months of 1940 confirms the foregoing statements. They reveal Asia, Russia, Japan, Australasia, the Philippines, and the Western Hemisphere outside the United States as open markets for American mining machinery and satisfactory sources of metals and minerals not produced in the United States in the desired quantity and grade.

Imports of Minerals

Table I, prepared from data furnished by the Foreign Minerals Division, Bureau of Mines, summarizes the principal imports of metals and minerals. Total imports are divided between those originating in the Western Hemisphere and the rest of the world in order to emphasize the position of the Western Hemisphere as a supplier of these commodities to the United States.

Antimony ore, for example, is imported almost exclusively from the Western Hemisphere. Mexico provides 75 per cent of the total, the remainder coming from South America. Chrome ore, by contrast, comes principally from South Africa, the Philippines, New Zealand, Turkey, and Greece. In the Western Hemisphere Cuba is the major producer. Manganese ore, ferro grade, also comes mainly from outside the Western Hemisphere—Russia, Africa, India, and the Philippines. Cuba and Brazil are the major suppliers in the Western Hemisphere.

Detailed study of the table will show the dominance of the Western Hemisphere in United States imports of nickel, bauxite, asbestos, amorphous graphite, vanadium ore, and grain and nugget platinum. On the other hand, the United States goes outside the Western Hemisphere for major imports of tin from British Malaya,

Table I—Origin of Imports of Metals and Minerals Into the United States

Gross weight in metric tons except as otherwise indicated

	1938	1939	Jan-May 1940, est.
Antimony ore			
Western Hemisphere	17,907	19,050	15,387
All other	65	.....	.....
Chrome ore			
Western Hemisphere	40,225	68,995	29,710
All other	357,736	253,612	253,470
Manganese ore, ferro grade			
Western Hemisphere	163,707	151,285	112,126
All other	327,637	485,905	342,438
Mica, films, splittings			
Western Hemisphere	7	31	.....
All other	891	1,186	.....
Nickel, ore, matte			
Western Hemisphere	6,613	12,897	6,026
All other	.....	.....	2
Nickel, pig, ingot			
Western Hemisphere	19,529	44,354	21,321
All other	396	692	49
Tin, bar, block, pig			
Western Hemisphere	528	258	5
All other	49,968	70,969	42,213
Tungsten, ore, conc.			
Western Hemisphere	14	342	691
All other	132	902	1,397
Bauxite			
Western Hemisphere	453,971	514,812	238,457
All other	9,036	13,715	.....
Aluminum, metals, alloys			
Western Hemisphere	1,124	3,680	925
All other	6,819	9,048	3,109
Asbestos, chrysotile crude			
Western Hemisphere	1,233	2,783	.....
All other	2,906	4,943	.....
Asbestos, blue			
Western Hemisphere	.....	.....	.....
All other	2,977	5,560	.....
Asbestos, other			
Western Hemisphere	46,394	66,688	.....
All other	4,718	2,369	.....
Graphite, amorphous, natural			
Western Hemisphere	9,679	10,648	.....
All other	3,635	6,294	.....
Graphite, crystalline flake			
Western Hemisphere	2	118	.....
All other	1,468	2,479	.....
Vanadium ore			
Western Hemisphere	9,055	14,237	8,152
All other	.....	.....	.....
Mercury [1]			
Western Hemisphere	.....	562	128
All other	2,362	2,937	43
Platinum [2], **ore, conc.**			
Western Hemisphere	842	3,435	300
All other	2,421	2,508	.....
Platinum [2], **grain, nugget**			
Western Hemisphere	21,409	24,817	11,485
All other	4,767	7,449	3,644
Platinum [2], **ingot, bar**			
Western Hemisphere	21	.....	.....
All other	44,070	68,022	14,407

[1] Flasks of 76 lb. each.

[2] Troy ounces.

and tungsten ore from China. Aluminum has been imported mainly from France and Norway. Crystalline flake graphite comes from Madagascar.

On the whole, analysis shows that the principal mineral imports into the United States originate either in the Western Hemisphere or in other parts of the world with which commerce is not seriously disrupted. This does not mean that there are no obstacles to the free flow of mineral imports. It shows, however, that they do not come from the war-ridden countries of Europe, but from other parts of the world with which tradeways are still open.

Exports of Mining Machinery

A similar condition prevails regarding United States exports of mining and metallurgical equipment. Europe has been relatively a minor buyer. By contrast, the Western Hemisphere market is enormously important, and the rest of the world not now dominated by Germany is a far better market than Europe ever was. Again the point to be observed is that, although there may be difficulty in shipping American mining machinery abroad, nevertheless the principal tradeways for this traffic are still open and not directly affected by Europe's war.

Table II—Value of United States Exports of Mining Machinery—1939

Export to	All Classes
Europe	$1,390,375
Russia	385,408
Western Hemisphere [1]	8,162,511
Africa, Asia, Australia [2]	5,873,706

[1] Includes Alaska, Hawaii, Puerto Rico, Virgin Islands

[2] Excludes Mediterranean Africa, Turkey, Arabia

Table II is compiled from figures furnished by the Machinery Division, Bureau of Foreign and Domestic Commerce. They are derived from an annual summary for 1939 not yet published, covering value of exports of (1) rock drills, (2) hoists and derricks, (3) crushing and sorting machinery, (4) concentrating and smelting equipment, and (5) all other mining and quarrying machinery. The table summarizes the value of exports in these five classes for 1939 and shows the distribution of the world market by grand divisions. Admitting that the European market is now closed to American shipping, the remainder of the important world market in 1939 is still open to commerce and trade. Volume of business in 1940 may be reduced, but the major markets are not lost by reason of war. And in 1939 these markets took over 90 per cent of the value of our total exports of mining machinery.

Examining the export market in greater detail, it is found that the leading buyer of United States mining machinery in 1939 was Canada. Next in order were the Philippines, Mexico, and the Union of South Africa. Figures for 1940 are not complete, but the Jan.-Apr. record shows the same four countries in leading positions as buyers of United States mining machinery. The volume of business for four months is proportionately as great as in 1939, and the markets are still open.

Summarizing the foreign trade situation, as far as it interests the mining and manufacturing industries, it appears that the tradeways on which the United States has relied for import of minerals and export of mining machinery are still open to traffic and only indirectly affected by the European war.

NEW BOOKS

EFFECT OF SULPHUR DIOXIDE ON VEGETATION. *National Research Council of Canada, Ottawa, Canada. Illustrations, charts, tables. Pp.* 447. *Price* $15.

EIGHT YEARS of scientific study and field observation are embodied in the sixteen chapters of this book. The work was undertaken by the National Research Council of Canada in connection with the so-called Trail smelter smoke case—an international legal issue between the United States and Canada relative to damage in Stevens County, Washington, by sulphur dioxide fumes from the smelter of Consolidated Mining & Smelting Company, Trail, B. C. The legal phases of the case having been completed, and claims for damage settled, the scientific studies are now made available to the public as a comprehensive investigation of the effect of sulphur dioxide on vegetation.

Field work in the affected area was extensive and elaborate. About half a million determinations were made of the sulphur dioxide content of the atmosphere. The annual growth rings of 10,000 trees were measured and charted for possible effects of sulphur dioxide. Artificial fumigation of alfalfa was maintained under controlled conditions throughout the growing season; and the rate of carbon dioxide assimilation by plants was measured at various concentrations of sulphur dioxide. Soils and water supplies were also studied. The volume is profusely illustrated with reproductions of photographs, some in color; and scientific data are tabulated and charted.

Results of this study will be of interest to scientists in agriculture and horticulture, and to industrialists concerned with smoke and fume problems.

THE GEOLOGY AND MINERAL RESOURCES OF THE NEIGHBOURHOOD OF RAUB, PAHANG, FEDERATED MALAY STATES. *J. A. Richardson, A.R.C.S., B.Sc., F.G.S., Geological Survey Department, F.M.S. Printed by Printers, Ltd., Singapore, Straits Settlements. Pp. 166. Price $3, Straits.*

THE tremendous tin industry of Malaya has hitherto overshadowed all other metalliferous production there, and this memoir is the first authoritative work on its potential gold resources. It has been limited to the area contiguous to the only payable gold mine.

Along the eastern slopes of the granite vertebra of Malaya there exists indubitably an auriferous zone nearly 400 miles long, whose northern working is in the French-owned Société des Mines d'or de Litcho, 2 miles from the Malayan border in Thailand (Siam). The mountainous tropical jungle has been hitherto an insuperable obstacle to prospecting, but the gold shed is abundantly visible in the scouring streams of the eastern slopes.

Richardson's work has fixed the auriferous areas within a narrow zone not more than 12 miles wide; and from the known geological conditions the area investigated will certainly be the prototype of the whole gold belt. The auriferous zone has been shown to consist of Permo-Carboniferous calcareous slates and limestones which have been pushed eastward and intensively buckled and faulted by the intrusive granites of the main range. Careful field work and assaying prove that the gold deposits are in genetic association with mid-Tertiary apophyses of the granite batholith such as granite porphyry and muscovite aplite. The assays of these rocks are important, and one mistake in the work is that sampling should have been carried further.

The investigation, however, has narrowed the potentially auriferous area to a reasonable width, thereby preparing the way for systematic economical prospecting. In this logical isolation of the basic geological essentials the unusual merit of Richardson's memoir lies.

The petrology of the rock series has received particular attention. Here again the work has been undertaken generally from the economic viewpoint. The investigation of the hybrid basic rocks, however, will interest the academic geologist.

In that portion of the memoir dealing with the economic geology as deduced from an investigation, ultimate associa-

tion with this mine indicates that the magnitude of the oblique faulting has not been satisfactorily established and secondly that secondary enrichment has played a far more important part than its somewhat cursory dismissal would indicate. The investigation, however, is a pioneer examination, and in such case there may be several interpretations of incomplete data. Richardson's memoir will, however, remain the basis of all gold investigation in Malaya.

J. C. COLDHAM

MINING DIRECTORY OF MINNESOTA, 1940. *By John J. Craig, Published by University of Minnesota and Mines Experiment Station, Minneapolis, Minn. Pp. 232 (6¾ by 4¾ in.).*

BEARING THE DATE MAY 1, 1940, this little volume, which appears annually, contains information as of the current iron-ore season on the Lake Superior ranges. Part I contains maps of the iron mining districs in the State, with a list of the Reserve properties. Part II catalogs the mine properties individually, giving in each case the location as to post office, range and township, shipments in recent years, and the mining interests involved in ownership and operation. Part III lists the operating and holding organizations with their subsidiaries in each case. Part IV is devoted to general statistics.

MINING YEAR BOOK OF AUSTRALASIA, 1940. *Compiled by Charles J. Penn. Published by West Australian Mining and Commercial Review, Ltd., Perth, W. A., Australia. Pp. 275. Price 21s.*

IN ADDITION to an authentic record of producing mining companies in Australasia, Federated Malay States, Siam, and New Zealand, this annual contains a mining catalog and directory of manufacturers' representatives, and a glossary of some terms used in mining and geology.

PHILIPPINE MINING YEARBOOK, 1940. *Ralph Keeler, editor, Mining Yearbook, Inc., Manila, P. I. Pp. 200. Price $1.*

AS THE official publication of the Chamber of Mines of the Philippines, this annual edition of the yearbook is a compendium of information relating to mining in the islands. In addition to a directory of mining companies, it gives production and financial data, a roster of mining men, and a buyer's guide to equipment and supplies. Several new features have been added.

ROBERT D. FISHER MINING MANUAL, VOL. 1, 1940. *Published by Robert D. Fisher & Company, 461 Eighth Ave., New York. Pp. 297. Price $10.*

THIS VOLUME, which has recently made its initial appearance and is not to be confused with any other book known as a "mining manual," is a compilation of the names and addresses of over 18,000 (according to the publisher) active and inactive coal, metal, and non-metallic companies in the United States, Alaska, and Canada. In addition are given the location of these companies' properties and, in a percentage of cases, additional information, sometimes financial, such as the value of shares, participating interests, leases, options, the exchange where stock is listed, and the like. By far the larger number of companies are each accorded less than five lines of space in a column 2⅜-in. wide, so that the information regarding any one company is usually not extensive. Thus the book is in a different class from other well-known mining handbooks, past and present. It will doubtless be useful to brokerage and investment houses and to others who wish to prepare lists of companies for circularizing purposes.

TEXT BOOK OF ORE DRESSING. *By Richards & Locke. McGraw-Hill Book Company, New York and London. Pp. 608. Price $5.50.*

ORIGINALLY WRITTEN in 1909 by R. H. Richards and revised in 1925 by the present authors, this standard work is now offered in its third edition, fully revised and brought up to date. Much of the material of former editions has been retained, but the chapter on flotation has been rewritten and expanded. Mill flowsheets show the latest practice, and the chapter on coal dressing appears in new form. Designed as a text for the student and operator, the book treats of the principles involved in the various operations of mineral dressing, and illustrates the machines used to accomplish the respective purposes.

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PUBLICATIONS

RECEIVED

Engineering Index. The 53th annual volume of 1,400 pages, with 27,000 annotations and 40,000 cross references to engineering literature. Material is selected from 2,000 periodicals and reports in many languages. Engineering Index, Inc., 29 West 39th St., New York.

Lake Superior Iron Ores. Average Analyses of Shipments by Ranges and Grades, 1939. Lake Superior Iron Ore Association, 1170 Hanna Building, Cleveland, Ohio. Pp. 4.

Michigan Iron Mines, Costs and Production, 1939. Compiled by F. G. Pardee, appraiser of mines, and G. E. Eddy, geologist, Geological Survey Division, Department of Conservation, Lansing, Mich. Pp. 8.

Iron Mining, Technology, Employment and Output Per Man. A WPA National Research Project in cooperation with U. S. Bureau of Mines, Washington, D. C. Pp. 264. No charge.

Quicksilver. California Journal of Mines and Geology, October, 1939, issued by State Division of Mines, Ferry Building, San Francisco, contains article entitled "Quicksilver Resources of California," by Alfred L. Ransome and John L. Kellogg. Pp. 353 to 486 inclusive.

Mechanical Shoveling in Underground Metal Mines. By McHenry Mosier and J. H. Steinmesch. Bulletin 423, U. S. Bureau of Mines. For sale by Superintendent of Documents, Washington, D. C. Pp. 97. Price 25c.

Silver Price Chart. High and low official New York quotations from 1900 to date, with provision for extending the figures to 1950. Handy & Harman, New York. Size 17x28 in. Price $1.

Transactions of the Institution of Mining and Metallurgy, Vol. 48, 1939. Published by the Institution, at Salisbury House, Finsbury Circus, London, E. C. 2, England. Pp. 862.

U. S. Bureau of Mines, Washington, D. C. has issued the following Information Circulars and Reports of Investigations (no charge).

Report of Investigation 3590, Electrolytic Method for the Production of Calcium Boride, pp. 21. Also R. I. 3502, Time Study Analyses Progress Report 3, Quarry Drilling, pp. 19. Also R. I. 3503, A Polarizing Comparison-Microscope for Use in Petrographic Measurements, pp. 8. Also R. I. 3508, Diesel Engines Underground—Composition of Exhaust Gas From Engines in Good Mechanical Condition, pp. 48. Also R. I. 3510, Cushioned Blasting, pp. 25. Also R. I. 3511, Explosive Properties of Cyclopropane—Prevention of Explosions by Dilution With Inert Gases, pp. 17. Also R. I. 3512, Contribution to Art of Smelting Lead Products, pp. 12. Also R. I. 3513, Concentration of Manganosiderite Ore From Leadville, Colo., pp. 6. Also R. I. 3516, Darkening Light-Color Soils With Coal-Mine Waste, pp. 6. Also R. I. 3469-R, Properties of Suspension Mediums for Float-and-Zinc Concentration, pp. 25. Also Information Circular 7101, Mining and Milling Methods and Costs in Alma District, Colorado, pp. 63. Also I. C. 7107, Cutting and Polishing Stones, pp. 23. Also I. C. 7116, New Metallurgical Experiment Station for U. S. Bureau of Mines at Salt Lake City, pp. 9. Also I. C. 7111, Operations at Haile Gold Mine, Kershaw, S. C., pp. 42. Also I. C. 7112, Mining of Feldspar and Associated Minerals in Southern Black Hills of South Dakota, pp. 104. Also I. C. 7114, Reduction of Quarry Accidents, pp. 19. Also I. C. 7115, Cars for Transporting Explosives, by C. W. Owings, pp. 6. Also I. C. 7117, The Potash Situation, pp. 6. Also I. C. 7118, More Jobs for Minerals, pp. 19.

U. S. Geological Survey has issued the following (for sale by Superintendent of Documents, Washington, D. C., at stated price): Bulletin 901, Clay Investigations in the Southern States, 1934–35, (deals with search for bleaching clays, including bentonites), pp. 346, plus maps, price $1. Also Bulletin 907, Geology of Alaska Railroad Region, by S. R. Capps, pp. 201, plus maps, price $1.25. Also Bulletin 914, Microscopic Determination of Ore Minerals, by M. N. Short, pp. 314, price $1.

Southern California, Current Mining Activity. An 82-page review. California Journal of Mines and Geology, Vol. 36, No. 1. Issued by State Division of Mines, Ferry Building, San Francisco.

Virginia. Geology and Mineral Resources of Warrenton Quadrangle, Virginia, Virginia Geological Survey, University, Va., pp. 94 plus map.

South Dakota. Annual report of the Inspector of Mines for 1939.

Canada. Mines and Geology Branch, Department of Mines and Resources, Ottawa, has issued: Report for Fiscal Year Ended March 31, 1939. Also Geological Survey Memoir 220, Mining Industry of Yukon, 1938, by H. S. Bostock, pp. 21, price 10c. Also Geological Survey Memoir 219, Halfway Lake-Beresford Lake Area, Manitoba, by C. H. Stockwell and C. S. Lord, pp. 67, plus map, price 25c. Also Bureau of Mines Report on Investigations in Ore Dressing and Metallurgy, July to December, 1938, pp. 132, price 50c.

Ontario Department of Mines, Toronto, has issued Part I of its Annual Report for 1939, including a statistical review of the mineral industry, a list of mines and quarries in 1938, and a report on individual mines and quarries in 1938.

Quebec Bureau of Mines, Quebec, P. Q., has issued report on Mining Industry and Statistics of Province of Quebec for 1938, pp. 130. Also Geological Report No. 2 on "Lower LaFlamme River Area, Abitibi District," pp. 23.

Brazil. National Department of Mineral Production. Rio de Janeiro, has issued the following, in Portuguese: Bull. 40, Petrology of Apatite Beds of Ipanema, State of São Paulo, by Viktor Leinb, pp. 52; Bull. 39, The Iron of Jequié, State of Baía, by Jose Lino de Mello Junior and Mario da Silva Pinto, pp. 56; also Bull. 41, Report of the Director, 1938, by Avelino Ignacio de Oliveira and Octavio Barbosa, pp. 180.

Transvaal Chamber of Mines, Johannesburg, South Africa, has issued Reports of the Executive Committee, Gold Producers' Committee and Collieries Committee for 1939. Pp. 39.

Federated Malay States. Report of Geological Survey Department for 1939. By E. S. Willbourn. Kuala Lumpur, F.M.S. Pp. 32. Price 7d, or 25c. Straits.

Uganda, Africa. Report of Geological Survey Department for 1939. Entebbe, Uganda. Pp. 38, plus map. Price, 2s.

PERSONAL ITEMS

A. W. Newberry, Longmeadow, Mass., is investigating occurrences of strategic minerals in the Western states.

P. H. Reagan, consulting mining engineer, of La Paz, Bolivia, spent July in the Argentine.

J. A. Williams has been made general superintendent of Alaska Juneau Mining Company.

Charles A. Mitke, recently consulting engineer for the Soriano interests of Manila, P. I., is now consulting engineer for the Philippine Iron Mines and other companies.

William A. Maxwell has joined the research staff of Foote Mineral Company, of Philadelphia. He will devote most of the time to research on process development.

Merle H. Guise, gold placer engineer, is examining gold placers in Idaho and Montana, his headquarters now being at the Hotel Boise, Boise, Idaho.

Paul W. Long has returned to the United States from Peru, where he completed a three-year contract as mine shift boss for Cerro de Pasco Copper Corporation. He is now at 406 Richmond Ave., Lead, S. D.

Thomas G. Murdock, for the past four years safety engineer for Minas de Matahambre, S. A., Pinar del Rio Province, Cuba, has been appointed Assistant State Geologist for North Carolina, with headquarters in Raleigh.

Elmer J. Olsen, Chisholm, Minn., assistant superintendent of the Hibbing-Chisholm district for the Oliver Iron Mining Company, has been transferred to Soudan, Minn., as resident superintendent of this mine for the Oliver Iron Mining Company.

A. F. Beasley, smelter superintendent at the Bunker Hill smelter of Bunker Hill & Sullivan Mining & Concentrating Company, who recently underwent an appendectomy operation at Kellogg, Idaho, is reported to be making an excellent recovery.

D. N. Matheson, formerly general superintendent of Bralorne Mines, Ltd., has been promoted to be general manager. **E. J. Chenoweth** and **G. H. Wilson** were promoted to general superintendent and mine superintendent, respectively.

Charles A. Banks, managing director of Bulolo Gold Dredging Company, Ltd., has been appointed liaison officer, on behalf of the Canadian Government, to be stationed in London in connection with the purchase of munitions and supplies for the Canadian forces.

J. B. Haffner, formerly vice-president and general manager of Consolidated Coppermines Corporation, Kimberly, Nev., has been appointed general manager of Bunker Hill & Sullivan Mining & Concentrating Company. He began his duties on July 17.

Neil O'Donnell has returned to Bolivia after a stay of about four months in the United States, during which time he visited a number of Western mining districts. Formerly general manager for three years of Cia. Huanchaca de Bolivia, at Pulacayo, he returns to Potosi as general manager of Cia. Minera Unificada del Cerro de Potosi.

W. E. Fenwick, for the past two years engineer in charge of development at the mines of the Lookout Mountain Mining Company, San Andreas, Calif., recently accepted the position of superintendent of King Solomon Mines, Forks of Salmon, Siskiyou County, and will initiate a development program under the direction of **Wilbur H. Grant,** consulting engineer.

W. A. Wood, consulting engineer, recently returned to New York from France, where he was employed as ordnance consultant to the French Government at Nancy. Mr. Wood left Paris at the time of the German invasion, riding on a soft-drink truck, traveling 25 km. in 24 hours along roads choked with refugees. He was previously employed by the Non-Ferrous Metal Trust of the U.S.S.R.

Dr. Jasper L. Stuckey, of North Carolina State College at Raleigh, has been appointed geologist for the State of North Carolina to succeed **H. J. Bryson,** who resigned recently to accept a position with a mining concern in Western North Carolina. Dr. Stuckey served as state geologist from 1920 to 1926, when he resigned to become head of the geology department at N. C. State College. Upon his resignation he was succeeded by Bryson. Under his new appointment he will not give up his work at the college, but will continue on the college faculty and will devote part of his time to the administrative duties of the geology office. Field activities of the state geology division will be carried on by **T. G. Murdock,** 39, a mining engineer in Latin America for the past several years.

Arriving at New York July 17 on the S.S. "Exermont," the following employees of Cyprus Mines Corporation, and their families, comprised sixteen of the eighteen passengers: Mr. and Mrs. G. W. Nicolson, of Los Angeles; Mr. and Mrs. F. A. Newquist and three small sons, of Missoula, Mont.; Mr. and Mrs. A. H. Pedler and infant son, of Ogden, Utah; Mr. and Mrs. R. H. Goings, of Los Angeles; and Mr. and Mrs. H. A. Storm and two daughters, of Denver. The "Exermont" carried 6,300 tons of copper concentrates from Cyprus Mines, now closed, and was one of the last merchant steamers to leave the Mediterranean.

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OBITUARY

John Ira Thomas, State Secretary of Mines of Pennsylvania, died in Philipsburg, in that State, on July 20, at the age of 58.

James Francis Flynn, who since 1910 had been associated with gold mining in Ontario, died in Niagara Falls, Ont., on July 4 at the age of 75.

Frank W. McLean, well known for many years as a superintendent and operator of mines in Arizona, New Mexico, and Mexico, died in Los Angeles, Calif., on June 26 last.

James F. Callbreath, secretary of the American Mining Congress from 1904 to 1934, died on Aug. 4 at Alamosa, Colo., at the age of 81. Since his retirement, Mr. Callbreath had been secretary emeritus of the Mining Congress.

Walter McDermott, long associated with mining and metallurgical interests of Great Britain and in former years well known on the Continent and in the United States, died on May 30 last in his 89th year.

Samuel C. Thomson, mining engineer and a director of Noranda Mines, died in New York City on July 12. He was 71. Mr. Thomson was an alumnus of Phillip Andover, Yale, and the Columbia School of Mines. He was actively engaged in mining in California and South Africa early in his career and in 1921 helped to organize the syndicate which organized and promoted the Noranda property, in Quebec.

John Michael Callow, mining engineer, inventor, and metallurgist, died at his home at Redhill, Surrey, England, on July 27 at the age of 73. Mr. Callow was born in England and received his education there. His early professional activities involved work in Australia and in various parts of the Western United States. After a distinguished career as a consulting engineer, he became president and general manager of General Engineering Company of New York in 1906, from which post he retired in 1933. Mr. Callow was the holder of eighteen patents for metallurgical processes, having invented the pneumatic flotation process, the Callow settling tank, and the Callow traveling belt screen. In 1925 he was awarded the James Douglas Gold Medal by the A.I.M.E., of which he was a life member.

John Michael Callow

When a man with a host of friends, many of them distinguished, dies, it is, perhaps, presumptuous for one of the throng to take it upon himself to thus write publicly. But, John Michael Callow did so many things that I admire, had so many qualities that I respect, lived so much a man, that I am compelled to do him this homage, not only because by doing so I somewhat assuage my sense of loss, but because broadcast knowledge of the man should become a part of the tradition of the profession that he adorned.

John Callow's technical achievements are badly and concisely summarized in the citation of his Douglas medal. They are better and more widely acknowledged, however, in the milling literature of 1910-1930, in which, it is safe to say, more than half of all mill descriptions named Callow cones or Callow cells.

The principle of the settling cone was already old when Callow was in swaddling clothes. But during the decade following the turn of the century, hundreds of these apparatus were specified in the designs of the big gravity concentrators. Their shipment in assembled form, which was necessary, if an expensive calking job was not to be done in the field, was the ultimate of wasted freight space. Callow cones were designed to be nested when all but the overflow launder had been assembled, and to permit of field attachment and leveling of this latter element by almost any laborer. The results were a most welcome simplification in design and operation, and notable savings in freight and erection charges. As the need for small individual deslimers and dewaterers passed with the change from gravity to flotation concentration, other apparatus displaced the Callow cone, but it remains today as uniquely fitted as ever to designs calling for small individual thickening units.

The Callow flotation cell was a similar practical embodiment of a known basic concentrating principle. Inventors had, since the early 80's, described half a dozen different methods of preferential buoying of sulphide minerals by attached gas bubbles. In 1906 the method of doing this by violent agitation of a pulp had been patented. During the succeeding decade this process was more or less withheld from zinc producers at large, to whose ores its application was somewhat understood, and ballyhooed to copper producers, whose ores could not, at the time, be treated by it. Callow came into this picture with the pneumatic cell, in which he floated copper ores in a machine that was cheaper to build and cheaper to operate than the gigantic mechanical egg-beater, and which operated by a different method. It saved power, had lower maintenance, was easier to control, and gave better recoveries on low-grade copper ores than its mechanical competitor. Its installation at the National Copper Company plant at Mullan, Idaho, described in the technical journals in 1916, was a landmark in milling history.

Not so well known, because the results did not carry his name, but of equal practical importance to the flotation industry, was the research that Callow initiated and directed, which culminated about 1920 in the discoveries by C. L. Perkins and R. E. Sayre of the nitrogen and sulphur types of chemical collectors (naphthylamine, thiocarbanilid, thiophenol, etc.). This work was confessedly pointed toward escape from the all-embracing patent claims that had been set up on the discovery that when an ore pulp is beaten up with oleic acid or tar oils selective separation of the sulphide minerals is possible. It succeeded not only in breaking the monopoly but in leading up to the present-day substantial perfection in recovery of sulphide values from ores.

Those of us who were active in flotation from 1915 to 1930 know that Callow was denied the financial reward and much of the professional honor that were his due for his outstanding contributions to the art. He suffered from the predisposition of our courts, compelled by their realization of scientific ignorance, to be persuaded that nature is simple, and that one practical application of one of her laws, once discovered, constitutes a natural and inevitable progenitor of all other practical applications of the same law.

Despite this predisposition, Callow's adversaries were unable to convince the courts that the pneumatic process was the same as the agitation process. But they were able to achieve the same practical effect through prevailing upon them to decide that the normal movements of pulps in a mill, from the ball mill to the flotation cell, which movements were utilized to distribute oils through the pulps fed to pneumatic machines, were the scientific and technical equivalents of the violent agitation of the antecedent process.

It is almost inescapable that in struggles such as these, when large sums of money and intense personal antipathies are involved, and when the court is not capable of judging the intrinsic character of the technical and scientific evidence offered, sharp practices will tend to creep in. Callow set himself uncompromisingly against the proffer of any questionable evidence by witnesses in his behalf. He insisted that all experimental results which were superficially in his favor be checked and tested to determine their accuracy, as rigidly and thoroughly as though they were to form the basis for a million-dollar design. If they failed full substantiation, they could not be used at all. He lost financially by this stand, but he rose thereby to a pedestal in the judgment and affection of his associates.

Callow lost his battle for his rightful share of the gigantic sums that were paid by the metal industry of this country for the use of flotation. He never complained. Instead, he formed the General Engineering Company, through which he and his associates, by applying their tremendous knowledge of flotation and allied milling arts to the design and construction of milling plants, recovered something from the wreck which the courts had left. When, ten years ago, he went to England to run the London branch of this activity, his many friends and associates in America hoped that either business or pleasure would provoke frequent trips to this country. Unfortunately, business did not, and failing health prevented pleasure trips. But the influence of Callow's knowledge and personality was as prevailing with his associates here during these years of absence as though he himself were just around the corner—as we hope he is.

ARTHUR F. TAGGART

Louis H. Metzgar

Louis H. Metzgar, general superintendent of the Alaska Juneau mine, died in San Francisco June 2, 1940. The death was sudden, unexpected, and came at the end of a vacation trip during which Mr. and Mrs. Metzgar were in the Eastern states.

The Alaska Juneau enterprise has interested the mining fraternity ever since its inception, and Metzgar's close association with it as operating official along with the late F. W. Bradley and with P. R. Bradley, president of the company, represented the three men responsible in a large measure for reviving an apparent failure and establishing it as a successful mine. Under the direction of P. R. Bradley and with Metzgar as executive in charge at Juneau the enterprise continued its successful career after the death of F. W. Bradley.

Metzgar was born in Clay Center, Kan., and at an early age went west. Without preliminary training in mining he obtained his knowledge through employment in the mining industry and by contact with mining men. From a miner he entered the field of contracting and leasing, where his natural ability enlarged his mining experience. His first position of consequence was with the Goldfield Consolidated in Nevada. From there he went to Aurora, in charge of Wingfield's operations at that place. Later he became general superintendent of the Treadwell group at Treadwell, Alaska. After the Treadwell and Mexican mines were flooded he became general superintendent of the Ready Bullion, and when John Richards, superintendent of the Alaska Juneau company, died, Metzgar was placed in charge of the Alaska Juneau. This was in 1922. Since that time and until his death he has been general superintendent of the Alaska Juneau.

Metzgar endeared himself to the people of Alaska and especially with the citizens of Juneau, where he was an important factor in the life of the community. Likewise with the employees of the Alaska Juneau he was held in high esteem for his competent handling of their interests. He increased efficiency but at the same time he greatly increased the compensation of employees. Careful operating management made an enterprise remunerative to all concerned.

Many expressions of regret and sympathy have come from Juneau and Douglas; from government officials, from citizens, from friends and from employees of the company.

Metzgar was of a positive character. He disliked publicity and was of a retiring nature. He was just in his decisions but decisive in action. His was a life of achievement. He was charitable and generous to a degree. Men like Metzgar give quality and character to the mining fraternity and play an important part in establishing American character.

P. R. BRADLEY.

AMERICAN

JOURNAL OF MINING,

Milling, Oil Boring, Geology, Mineralogy, Metallurgy, etc.

GEORGE FRANCIS DAWSON, EDITOR.

75th Anniversary of E. & M. J. in 1941

Next year — March 21, 1941, to be exact — will mark the 75th anniversary of the founding of what is today Engineering and Mining Journal. Its immediate antecedent, the American Journal of Mining, began publication March 31, 1866, and continued under that title for three years, when the present name was adopted.

Diamond Jubilees are not yet common in American industrial journalism, so we shall feel justified in celebrating our own in a manner befitting the importance of the mining industry. March 1941 will roll around too soon to enable the editors to do a satisfactory job, so we shall postpone actual recognition of our 75th birthday until August. The issue for that month, however, will be something to look forward to.

Naturally the editors are now laying plans for the Diamond Jubilee number, but they invite suggestions from subscribers who may have ideas for the issue — topics for discussion, incidents of importance, anecdotes of interest, photographs of early mining scenes, etc. We hope to produce an issue that will record the footprints of the great American mining industry, with which E. & M. J. has been contemporary. The discovery of gold in California in 1849 and in Colorado in 1859 were the only major mining developments that antedated the establishment of E. & M. J. in 1866.

So for the next year the editors of E. & M. J. will be directing their efforts toward the production of something that will be worthy of the industry they represent. They will welcome your cooperation.

PARK BUILDING.

VOLUME I.—MARCH TO SEPTEMBER, 1866.

NEW YORK:

WESTERN & COMPANY, PUBLISHERS AND PROPRIETORS,

37 PARK ROW AND 145 NASSAU STREET

What Metal Statistics Show

THE blockade of Europe continues to exert a depressing influence on copper, lead, and zinc producers in Mexico and South America. This country has felt the pressure in lead for a long time and it finally brought a lower price on Aug. 6, from 5c. to 4.85c. per pound, New York, as large accumulations of foreign lead continue to seek a market. In the United States, production and consumption of base metals are being maintained in reasonable balance. Strategic metals and ores are steadily being accumulated by the Government. In Canada, the British Ministry of Supply has exercised its option to purchase the copper supply in excess of Canada's requirements for twelve months beginning Oct. 1.

Stocks of refined copper in the United States—duty-free metal—increased 20,922 tons during June, reflecting smaller deliveries and an almost unchanged production rate. Production of refined copper was 86,077 tons during June, with production of blister 79,064 tons.

Domestic deliveries of 61,716 tons for June were below expectations. However, domestic deliveries for the first half of 1940 averaged 69,445 tons a month, which compares with a monthly average of 49,235 tons, first half of 1939.

The duty-free copper statistics of the Copper Institute, in short tons, follow:

	Production (a) Crude	Refined
January	89,598	80,501
February	76,145	82,761
March	85,796	86,295
April	84,366	80,964
May	(b) 82,682	86,029
June	79,064	86,077
Totals	497,651	502,627

	Deliveries to Customers Domestic	Export	Totals
January	91,428	13,117	104,545
February	63,215	9,594	72,809
March	64,376	7,517	71,893
April	68,665	2,974	71,639
May	69,467	7,018	76,485
June	61,716	3,439	65,155
Totals	418,867	43,659	462,526

	(c) Refined Stocks End of Month
January	135,441
February	145,393
March	159,795
April	169,120
May	178,664
June	199,586

(a) Mine or smelter production or shipments, and custom intake including scrap. (b) Corrected. (c) At refineries, on consignment and in Exchange warehouses, but not including consumers' stocks at their plants or warehouses.

▶LEAD—Deliveries of lead to domestic consumers during the first half of 1940 totaled 268,723 tons, against 232,218 tons in the same period last year. Cable interests, battery manufacturers, and ammunition makers have taken more lead this year than in 1939.

The May and June statistics for refined lead, according to the American Bureau of Metal Statistics, in tons, follow:

	May	June
Stock at beginning	63,610	62,955
Production:		
From domestic ore	37,918	34,041
Secondary and foreign	8,350	8,265
Totals	46,268	42,306
Domestic shipments	46,919	49,904
Stock at end	62,955	55,343

▶STRATEGIC MATERIALS — The United States Treasury has announced that purchases of strategic materials as of June 30, 1940, show the following totals:

Tungsten, 449 short tons	$500,944
Quartz crystals, 11,800 lb.	98,875
Optical glass, 11,400 lb.	75,200
Manila fiber, 14,800 bales	234,935
Chromium ore, 64,500 long tons	1,847,850
Pig tin, 6,124 short tons	5,819,916
Manganese, 86,500 long tons	2,575,368
Quinine sulfate, 700,000 oz.	404,600
Total	$11,557,488

Purchases enumerated were made under the strategic materials program covering the fiscal year ended June 30, 1940. Purchases for the current fiscal year will be substantially larger. The new program calls for the acquisition of 75,000 tons of tin, 150,000 tons of rubber, with other items not yet announced.

▶ALUMINUM—A loan of $15,800,000 to the Reynolds Metal Company for the purpose of producing and processing aluminum was recently announced by the Reconstruction Finance Corporation. The new plant will probably be erected in the Tennessee Valley. The company heretofore has engaged only in processing aluminum and has purchased materials from the Aluminum Company of America. Federal Loan Administrator Jesse Jones declared that from the standpoint of national defense, it is desirable to have as many producers of aluminum as possible. The capacity of the plant will be about 10,000 tons of aluminum ingot annually, using foreign and domestic ores.

▶ZINC—The June and July statistics of the American Zinc Institute, covering all grades, are summarized as follows in tons:

	June	July
Stock at beginning	(c) 70,502	65,227
Production	48,660	51,944
Production daily rate	1,622	1,676
Shipments	(a) 53,935	(b) 57,661
Unfilled orders	59,043	63,726
Stock at end	(a) 65,227	(b) 59,510

(a) Includes 2,342 tons exported.
(b) Includes 1,735 tons exported.
(c) Revised.

Figures covering operations of the Prime Western division, for June and July follow:

	June	July
Stock at beginning	29,301	25,460
Production	19,302	20,698
Shipments	23,143	26,139
Stock at end	25,460	20,019

E & M J Weighted Index of Non-Ferrous Metal Prices

(100 is composite for 1922–3–4)

1929	110.33	1934	69.59
1930	82.87	1935	74.66
1931	60.20	1936	73.45
1932	48.26	1937	90.86
1933	59.79	1938	73.67
		1939	77.71

	1938	1939	1940
January	75.56	77.12	80.85
February	73.43	76.89	77.23
March	72.41	77.09	77.94
April	71.19	74.79	77.19
May	69.15	73.61	77.68
June	67.55	73.17	78.85
July	72.95	71.95	76.72
August	73.94	73.88	.....
September	74.70	83.07	.....
October	77.61	84.25	.....
November	78.36	83.80	.....
December	77.13	82.89	.....

Ferro-Alloys Shipped in 1938 and 1939

Domestic production of ferro-alloys in 1939 was 735,171 gross tons, an increase of 26 per cent over 1938. Output was made in 13 blast furnace plants, 16 electric furnace plants, and 3 aluminothermic plants; in addition, 3 plants made ferrophosphorus and 2 plants made ferrosilicon as by-products.

Shipments of all classes of ferro-alloys amounted to 841,162 tons in 1939, an increase of 81 per cent over 1938. Ferro-alloys shipped from furnaces in the United States during 1938 and 1939, by kinds, as reported by the Bureau of Mines, were as follows:

	1938 Gross Tons	1938 Value	1939 Gross Tons	1939 Value
Ferromanganese	223,720	$19,144,884	296,631	$24,137,211
Spiegeleisen	24,939	728,830	84,739	2,484,042
Ferrosilicon (a)	163,773	7,999,661	343,822	16,850,356
Ferrotungsten	484	1,453,227	1,609	4,846,386
Ferrotungsten	484	1,453,227	1,609	4,846,386
Other alloys (b)	44,601	12,662,971	101,041	26,949,122
Totals	464,112	$42,459,513	841,162	$76,156,588

(a) Seven per cent or more silicon. (b) Includes ferroboron, ferrochromium, ferrocolumbium, ferromolybdenum and calcium molybdate, ferrotitanium, ferrovanadium, ferrozirconium, silicomanganese, silicospiegeleisen, and zirconiumferrosilicon.

Milling capacity at the concentrator of the Walker mine, in Plumas County, Calif., is being increased by the addition of screening equipment. Present production at the mine is about 1,600 tons of copper ore daily

CALIFORNIA

Kelsey Mine Being Rehabilitated

California Aztec Mining Company plans extensive development of recently acquired properties in El Dorado County—Central Eureka Mining Company increases mill capacity

▶ The Guilford, Kelsey, and River Hill properties, comprising some 900 acres of patented mining claims north of Placerville, El Dorado County, have been acquired by the recently organized California Aztec Mining Company, and extensive development work is planned. Current work is centered at the Kelsey gold mine, where a crew is employed underground on development and another in reconstructing the mill, the capacity of which is to be increased from the present 75 tons to 300 tons by fall. Future plans include construction of surface plants at the Guilford and River Hill holdings, and additional milling facilities. Officers of the company include Tasker L. Oddie, president; Malcolm H. Carpenter, executive vice-president and general manager; and C. E. Halliburton, director.

▶ To increase the capacity of the mill to 200 or more tons, the Central Eureka Mining Company, Sutter Creek, Amador County, has completed installation of a new 6x7-ft. Hendy ball mill, a Dorr classifier, and a jig. Table concentration has been discontinued, and 20 of the 40 stamps are used for coarse crushing. The mill product is subsequently treated by flotation and cyanidation. Underground, development is in progress between the 3,000 and 3,500 levels. A modern all-steel change house to accommodate 200 men has been completed at the Old Eureka mine surface plant. Operations at the property are directed by James Spiers, general superintendent.

▶ About 500 tons of tailings a day are treated at the Plymouth tailings plant at Plymouth, Amador County, operated by the Argonaut Mining Company, Alex. Ross, general superintendent. Material is reclaimed by hydraulic methods and after passing through riffled launders goes to the flotation plant, with the tailings receiving subsequent treatment in a sand-slime cyanide plant. At the South Empire shaft of the Plymouth mine holdings, a new head frame and hoisting equipment has been installed, and underground development work has commenced. Hal M. Lewers is superintendent of the Plymouth unit of Argonaut Mining Company, Jackson.

▶ Alterations completed recently at the concentrator of Carson Hill Gold Mining Corporation at Melones, Calaveras County, include installation of six Fagergren flotation cells and three Pan-American pulsator jigs in place of the old concentrating tables. Flotation tailings are pumped to the near-by cyanide plant, and concentrates are reground and cyanided separately. Mine production exceeds 1,100 tons a day, of which one-third is obtained from open-pit operations. The underground Melones shaft has been sunk to the 3,500 level, where development is in progress. John A. Burgess is general manager.

NEVADA

Property in Dixie Valley Being Prospected

Goldfield Consolidated Mines Company determining extent of good ore found near surface—Gold Point Currant Creek Mines Company plans to build mill

▶ Control of the Comstock-Keystone Mining Company, with gold property and small mill in Dixie Valley, Churchill County, has been acquired by the Goldfield Consolidated Mines Company. Orebodies of large volume and of high grade are said to have been opened in the relatively shallow work accomplished, but at 100 ft. depth a flow of hot water precluded further sinking with present equipment. Core drilling is in progress for the purpose of prospecting the ore zone at depth and ascertaining if deeper levels can be worked by pumping. W. A. Swan is president and H. J. Amigo is vice-president. Main offices are now in the Crocker National Bank Building, San Francisco. Work at the mine is directed by Herbert N. Witt.

▶ In driving a new deep-level tunnel on property of the Gold Point Currant Creek Mines Company, in Nye County, a 6-ft. width of ore of high mill grade has been exposed, apparently the same vein that is opened on the surface and in an upper tunnel, some 400 ft. above the new level. In driving south on this vein a cross fissure has been opened in which narrow ore of exceedingly high grade is found. Plans were announced for early construction of a 150-ton cyanide mill. The company was formed recently as a merger of the Comstock Gold Point Mines Company and the Currant Creek Mining Company. Mine offices are at Ely and John N. Richardson is manager.

▶ The new main shaft of the Gilded Age Mining Company in the Osceola district, eastern White Pine County, has reached a depth of 125 ft. and will be continued to the 700 ft. according to Ray E. Wimber, manager, with an office at Ely. Three shifts are now employed in sinking.

▶ Operation of the reconditioned 200-ton flotation mill at the Lucky Boy silver-lead mine, near Hawthorne, Mineral County, was started July 22 by the Champion City Mines, Inc., which has a lease and option on the property. J. A. Lyon, of Hawthorne, is manager.

▶ New work is to be undertaken by the Rio Grande Copper Company, with property adjoining the Rio Tinto mine of the Mountain City Copper Company in northern Elko County. An option on the company's claims was relinquished in March by the Sunshine Exploration Company, Ltd., a subsidiary of Sunshine Mining, of Idaho. J. A. Davidson, of Elko, is president of the Rio Grande company.

▶ With recent final payment of $60,000, title to the Rip Van Winkle lead-zinc-silver mine, in the Merrimac district north of Elko, passed into the hands of a Utah group including officers of the Utah Copper Company, who have operated the property for the past year and have provided a 100-ton flotation mill. The Rip Van Winkle Mining Company has been formed to take over the property from the Alaska Improvement Company, which has owned it for many years. L. S. Breckon, Utah copper geologist, is president-manager.

▶ The Caliente Cyaniding Company completed in July the treatment of higher-grade tailing from the old Delamar cyanide mill, in the Delamar district, Lincoln County, after having recovered gold to the value of $781,490.95 from 585,979 tons, according to a report by H. L. Hazen, Lovelock, Nev., president and manager. Milling has been discontinued, but some 200,000 tons of tailing, with value below 90c. per ton, will be treated by the heap-leaching method.

▶ Under an agreement filed at Goldfield, county seat of Esmeralda County, E. L. Cord, retired automobile manufacturer, acquires control under long-term lease of the Mary mine and other properties of the Black Mammoth Consolidated Mining Company in the Silver Peak district, where he has operated the Mary mine and a 300-ton mill under the name of Prescott Lease.

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Bagdad Copper Corporation, operating in the Hillside mining district near Bagdad, Ariz., is producing around 300 tons of copper ore per day, which is treated in the company's flotation plant. The above views shows the mine surface plant, 300-ton flotation plant, and the power house on the right

ARIZONA

Water Shortage Effects Mining Operations

Mines in several districts hampered by severe heat and drought—Magma Copper resumes smelter operations following summer shutdown—Nickel deposit attracts attention

▶ Mine and mill operations at the Miami Copper Company have been on a curtailed basis due to a water shortage caused by a drought, which has also affected operations in other parts of Arizona. The company recently purchased the Old Dominion mine, near Globe, from which additional water will be obtained. A pipe line is being laid to the Miami mine, and completion is expected during August, when operations are expected to return to normal. A. J. Winther is general manager.

▶ Magma Copper Company resumed operations at its smelter on Aug. 5, following the customary summer shutdown for repairs.

▶ On July 22, W. J. Graham, secretary, Arizona Mineral Resources Board, declared that a deposit of nickel had been found by the Bureau of Mines in prospecting for strategic minerals. The deposit is in northwestern Arizona, near Littlefield, and is said to be of low grade, surface samples indicating 0.68 per cent nickel.

▶ W. S. Segar, Box 243, Chloride, Ariz., is operating the old Silver Hill mine just south of Chloride. He has recently taken a lease on near-by mill for concentrating the ores.

▶ The Superior Ore Buying Company, at Superior, is installing a new Allis-Chalmers sampler. A new 50-ton Blake crusher was recently installed. The company handles an average of 100 tons of custom ore per month, mostly small lots from various operations throughout the central part of the State.

▶ Work has been started on the Consolidated Gold Mines property, in the Dos Cabezos district. The group consists of 37 unpatented claims. A general reconditioning of the mill and power house is under way. The shaft is to be sunk to the 900-ft. level. R. Cartwright, of Wilcox, is in charge of the work.

▶ A pilot mill is to be installed at the Golconda mine for the initial treatment of the ores with other units to be installed when the flowsheet is worked out. E.M. Leonard, of Kingman, is resident manager of the company, and H. B. Lawrence, of Los Angeles, is president.

UTAH

Miners Sign Two-Year Labor Contract

Base rates of daily pay increased and vacations given after one year's service —Operations resumed at American Flag mine

▶ Mine operators and representatives of the International Union of Mine, Mill and Smelter Workers on July 16 signed a two-year agreement, effective July 1, 1940, regulating wages in the Utah metal industry. The new wage scale provides for a wage increase of 20c. per shift on the base rate, gives workers one-week vacations after one year of service, and names the International Union of Mine, Mill and Smelter Workers as the official bargaining representative of workers. The contract was signed after Dr. John R. Steelman, chief of the United States Labor Department's conciliation division, came to Salt Lake City to arbitrate the dispute, which threatened to end in a strike. Close to 5,000 members of twelve labor unions and 3,000 non-union miners and smelter workers will be benefited by the new wage schedule. When copper falls below 9c. a pound, the minimum under the new scale is to be $4.70 a day for underground work and $4.20 for smelter workers. At 9c. a pound for copper, machine workers will receive $4.95 daily. From 9c. to 12c. a pound, a 25c. per day increase is provided for every half cent rise in the price of the metal. Starting with 13c. per pound, the advance is 15c. daily for every three-quarters of a cent rise in the price of copper. If the price of silver changes from 71.11c. an ounce, wage rates will increase or decrease 2c. a shift for each 1c. variation in the silver price.

▶ Operations have been resumed at the American Flag mine, Park City, by the Marsac Mining Company, James B. Allen, president and manager, reports.

▶ Miners and employers will ask the 1941 Utah State Legislature and federal officials to exempt mine lessees from the provisions of the Federal wage-hour act. A recent Utah State Supreme Court decision, holding leasers subject to the unemployment insurance act, has done much to restrict leasing activity.

▶ Early in August officials of the International Smelting & Refining Company will finish working the tailing dump of the old Ophir Hill mine, at Ophir. Six hundred tons a day has been milled since December, 1938, completing the treatment of 400,000 tons.

▶ The San Rafael Mines, Inc., has started shipping 50 tons daily of manganese ore from its property, 10 miles south of Green River in Grand County to the Columbia Steel Company at Springville.

▶ Operations have been resumed at the American Metal Mining Company, Big Cottonwood Canyon, Salt Lake County. New Quincy officials report the discovery of new ore on the 900-ft. level of the Park City property.

▶ The Mercur Dome Mining Company shaft at Mercur is nearing the 650-ft. mark, officials report. Shipment of three carloads of ore weekly is now the production rate at the Old Hickory mine, near Beaver, according to the report of Edward Schow, manager of the Prosper Mining Company, which owns and operates the property. Directors of the Honey Boy mine, near Milford, recently signed a contract for 1,000 ft. of development work with the Pacific Leasing Company.

▶ The Iris Mining Company is erecting a 50-ton rod mill at its Marysvale property.

▶ Discussion of mining and metallurgical problems, an air-view reconnaissance of Utah mining districts, field inspection, a trip to the Bingham Canyon "Galena Days" celebration, and visits to Utah scenic spots, all are included on the regional meeting of the American Institute of Mining and Metallurgical Engineers to be held at Salt Lake City Sept. 10-13. Among the speakers will be, President Cornelius F. Kelley, announces D. D. Moffat, chairman of arrangements, and Colonel D. C. Jackling and President Herbert G. Moulton of the Institute. Climax Molybdenum mine operations will be described by F. S. Nicholas, assistant general superintendent, and E. J. Duggan, mill superintendent. Clinton H. Crane, president of the St. Joseph Lead Company, will deliver a paper on the lead-zinc industry. Delegates will be flown in a 21-passenger plan over Bingham, Tintic, and Park City districts. The Utah Copper Company is planning a special dinner-dance at its Gemmell Club in Bingham on Sept. 12.

Small Milling Plants Do Operate Profitably

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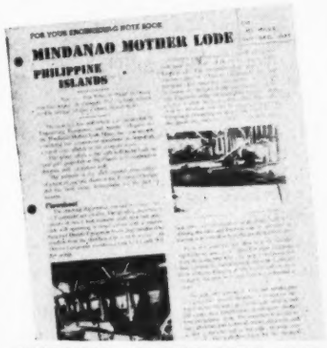
RESULTS obtained by small mills are described in the pages of the publications illustrated here. These valuable engineering data sheets, published in past issues of DECO TREFOIL, are available from Denver Equipment Company. Simplified flowsheet design and standard equipment are essential to the success of every small milling plant.

CENTRAL ZEBALLOS, B. C., Canada. 50-ton mill treating gold ore. Jig and amalgamation recovery 43.26%; flotation recovery 54.41%. Overall recovery 97.67%. Milling costs $2.68 per ton. Complete mill cost $24,856.76.

HAILE GOLD, N. C. 125-ton plant expanded to 250 tons. Gold recovered by cyanidation in complete Denver Plant, including washing tray thickeners, and precipitation units. Milling costs 76.75 cents per ton.



MINDANAO MOTHER LODE, Philippine Islands. 200-ton cyanide plant with flotation equipment providing treatment for sulphide ores. Flowsheet includes Denver Side Air-lift Agitators and Denver flotation cells.

GOLDEN ANCHOR, Idaho. 50-ton mill treating gold-silver ore. Recovery by amalgamation from jig concentrate, 73.3% gold and 2.34% from concentrating table; total recovery 93.03% gold. Milling costs $2.70 per ton.

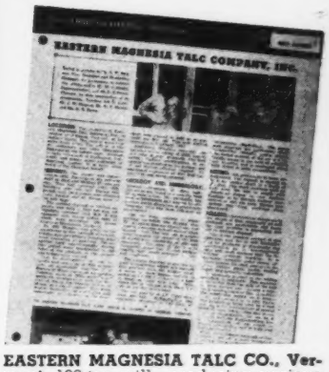
LAMARTINE MINES, Inc., Colorado. 75-ton plant handling gold ore. Flowsheet includes jigs, amalgamation and flotation. Over 85% of gold values secured as bullion from amalgamation of jig concentrates. Overall recovery about 97%.

HONG KONG MINES, China. 150-ton mill treating lead-silver ore. Straight flotation flow-sheet using Denver Equipment, which produces 71% lead concentrate which also contains 17 oz. of silver per ton. Overall recovery 95% of lead—85% of silver.

SEAL HARBOR, Nova Scotia, Canada. 225-ton mill treating gold ore with 90% recovery by amalgamation of Denver Mineral Jig concentrates with remaining 10% secured from cyanidation of amalgamation tailing. Milling cost 61.99 cents per ton.

WENDIGO GOLD, Ontario, Canada. 90-ton mill treating gold-copper ore. Recovery 87% of copper and 93.95% of gold. Gold recovery obtained is as follows: Denver Jig recovers 69.43%; Table recovers 16.69%; and flotation recovers 7.83%. Milling costs $1.88.

LA CHIRIPA Y ANEXAS, Sinaloa, Mexico. 20-ton mill now expanded to 100 tons. Gold ore treated by cyanidation—extraction 97%. Most interesting cyanide plant starting with small Denver Unit.



EASTERN MAGNESIA TALC CO., Vermont. 100-ton mill—producing various grades of talc for many industries. Flowsheet includes dry grinding section and wet milling—Denver flotation.

THE IMA MINES, Idaho. 115-ton mill treating tungsten ore producing concentrate containing from 65% to 70% WO_3—over 85% of the tungsten is obtained with Denver Mineral Jigs; balance by flotation and tables.

ELDORADO, N.W.T., Canada. 50-ton plant treating pitchblende and silver. Flowsheet includes gravity concentration for recovery of pitchblende and flotation in Denver "Sub-A" Cells —producing 678 ounces of silver per ton, in a silver-copper concentrate.

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NEWS FROM Washington

By Special Correspondent

IT LOOKS AS THOUGH the fiscal year which began July 1 would require spending by Uncle Sam to the tune of nearly 13 billion dollars. That amount might be expanded or directly committed for immediate deliveries without exceeding the new public debt limit. Of course that stupendous sum will not be available unless new tax levies, discussed elsewhere in this page, are imposed and prove really productive.

Large-scale contracts for defense procurement and manufacture have been announced. Disbursements up to mid-July under negotiations of the National Defense Commission were of the order of 1½ billion dollars. That sum does not include contemporary spending under normal procedure by either civilian or military officials, not even that which is largely preparedness in its significance.

Don't Expect Too Much Too Soon

DEFENSE PREPARATIONS are proceeding fairly well, considering the fact that the country is not at war and consequently not operating under rigid war-time economy. The Defense Commission is trying to inject business procedure into the general program, advising the Government to cut red tape in negotiating contracts and speed up legislation that will enable industry to move into production rapidly. Chief item of concern is the program for excess profits tax and the allowance for amortization of war-time plants. Industry needs assurance on these points before proceeding with plant construction or expansion, and production.

Such delays as occur in the preparedness program are mostly inherent in Government and not in industry. But industry may yet be blamed by the New Deal, and the Defense Commission may be made scapegoats, if the defense program bogs down in vital spots. Industrialists know that it takes months to put a production program into effect, but the public is not so well informed. It may be critical of delay when so much money has been made available, and may fall for Administration criticism. So the country ought to be prepared to discount political criticism in an election year, and realize that the industrialists on the Defense Commission are accomplishing things up to the limit of their authority, and are trying to expedite governmental cooperation with industry.

Tin Smelting in Prospect

PLANS FOR A TIN SMELTER in the United States are still in the conference stage, no decision having been reached as to who shall build it, where it shall be built, who shall operate it, or where the concentrates will be obtained. Key man in the final negotiations will probably be Simon I. Patiño, president of Bolivia's largest producer of tin—Patiño Mines & Enterprises Consolidated. Mr. Patiño has been in Europe, but is expected here for important negotiations with the Defense Commission. If arrangements can be made for a supply of concentrates that will not be cut off when the war is over, there is reasonable prospect of establishing a tin-smelting industry in the United States, using Bolivian and possibly other ores. Bolivia's output could be 30,000 to 40,000 tons of tin per annum, which is roughly one-half the consumption in the United States.

Meantime an agreement has been concluded by the Reconstruction Finance Corporation, the Metals Reserve Company, and the International Tin Committee for the purchase of not less than 75,000 tons of tin for reserve purposes. The Corporation will advance money to the Company to buy all available tin at 50¢ per pound until June 30, 1941. Such tin will not be made available to private industry until after Jan. 1, 1944; and of the stock then on hand not more than 5 per cent, or a maximum of 5,000 tons, shall be liquidated in any three-month period. This arrangement is probably the most favorable that could possibly be made for quickly acquiring a reserve stock of the metal.

Wage-Hour Rulings

UNDER NEW RULINGS of the Wage-Hour Administration, mining employers have two ways of mitigating the rigid hourly requirements of the Wage-Hour Act. The "escapes" from the 42-hour week (it will drop to 40 hours in October) are: 1. Pre-payment of wages or "time off" to build up an hourly reserve for peak periods. 2. Six-month, 1,000-hour contracts.

Permission to use a pre-payment plan was given by the Wage-Hour Administration in a new interpretation of the Act promulgated in July. Under this system, employers pay workers more each week than they have earned, thus building up a reserve of "overtime" due to employer. When a rush job requires overtime, the extra hours are charged off against the reserve. It is important to note, however, that in charging off such overtime, pay for time and one-half must be allowed. A variation of this same purpose is available in plants operating on a bi-weekly, semi-monthly, or monthly pay period. In such establishments, when employees work overtime during the first part of the pay period they may be given time off calculated at time and one-half during the remainder of the pay period to maintain the wage paid at a stated level.

The six-month, 1,000-hour contract plan permits employers with such agreements to disregard weekly working hours during the contract's life, just so hours worked do not exceed 1,000. For the six months of a year for which there would be no hours-exemption contract, the regular weekly hour limit would apply. The ruling does permit two six-month, 1,000-hour contracts; but if this is the case, the 1,000-hour limit must be observed over all intermediate periods of 26 weeks, as well as for the specific periods of the contracts. Annual contracts for 2,000 hours also are permitted.

Hemisphere Defense

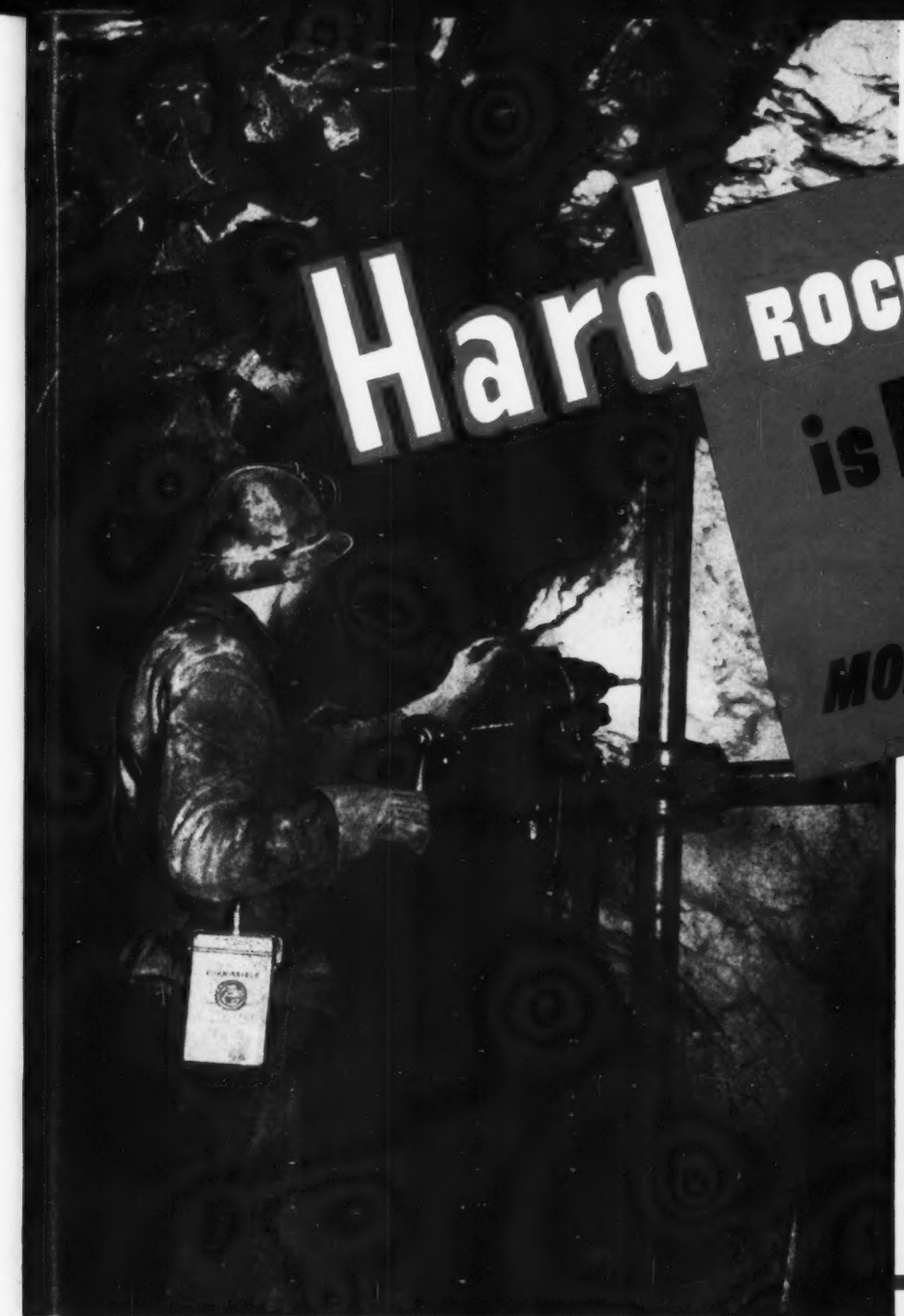
WHEN HITLER OVERRAN EUROPE and mopped up a lot of defenseless countries, he caused no little concern for the safety of the Western Hemisphere. Immediately there was talk of hemisphere defense among the American nations, and some loose thinking about how it might be accomplished. Later a Pan-American conference at Havana gave sober thought to effective plans for confining Hitler to the Old World.

The best hemisphere defense will probably be found in closer business relations among the countries of North, Central, and South America. Somehow, men and money seem to achieve things otherwise difficult or impossible of accomplishment. The United States might well have had ten or a dozen mining engineers in Latin America for the past decade, helping those countries to survey and develop their mineral resources. It is still not too late to spend $100,000 a year on such relations, with the prospect of discovering mineral resources that will supplement those of the United States. We have the money—more than we need or know how to use—and might as well spend some of it to help neighboring countries to the South explore and develop a continent that still has geographical frontiers such as the United States had a generation or two ago.

Manganese Proposals

SO MANY PROJECTS have been submitted at Washington for the recovery of manganese from low-grade domestic ore that a special technologic committee has been named to review all proposals. This committee consists of high ranking scientists and engineers, and has been appointed by the National Academy of Scientists, through an arrangement with the Minerals Division of the National Defense Advisory Commission. Upon the committee's findings may depend in large measure the disposition of the fund of $2,000,000 which Congress placed at the disposal of the President for the construction of pilot plants to beneficiate low-grade ores or to produce electrolytic manganese.

Personnel of the technologic committee is of itself a guarantee of competence and fairness in considering the merits of the various proposals that have been made. The Chairman of the Committee is Clyde Williams, Director, Battelle Memorial Institute, Columbus, Ohio. The Secretary is A. C. Fieldner, Chief, Technologic Branch, U. S. Bureau of Mines. Other members are: F. G. Cottrell, Washington, D. C.; James Critchett, vice-president, Union Carbide



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and Carbon Research Laboratories, New York City; John V. N. Dorr, Dorr Company, Westport, Conn.; Charles H. Herty, Jr., metallurgist, Bethlehem Steel Company, Bethlehem, Pa.; Donnel F. Hewett, Principal Geologist, United States Geological Survey, Washington, D. C.; John Johnston, Director of Research, United States Steel Corporation, Kearny, N. J.; and Gilbert Seil, Director of Research, E. J. Lavino Company, Philadelphia, Pa.

One proposal of the Bureau of Mines contemplates a scheme like this: Low-grade ore would be crushed, then floated, tabled, or otherwise concentrated. The effort would be made to get a fine concentrate at least equal in manganese content to ferro-grade ore—that is, 50 per cent Mn. Preliminary small-scale trials indicate that half of the contained manganese in the crude ore could probably be so recovered. The concentrates would, of course, then require sintering to put them into usable and storable physical form.

The residue of this concentration would then be leached for extraction of as much of the remaining manganese as was feasible. The leach liquor so developed would be used for the proposed electrochemical deposition of metallic manganese. That product would either be stored or used experimentally in government projects just as the ore concentrate. Preliminary studies indicate that perhaps 30 per cent of the contained manganese in the crude ore would be recovered as metal. The remainder of 20 per cent would be wasted, according to present process indications.

As indicated in *E.&M.J.* last month, it is hoped that some other Government agency would buy and own the ore. That agency would deliver the low-grade ore, perhaps 15 to 16 per cent Mn, and would take away the concentrate and metal for government use or storage. Thus the Bureau's money would be spent on the pilot plant and its operation. None would be needed for ore or freight.

Taxes and Amortization

THE MINING INDUSTRY can reasonably expect that the top bracket of the new excess profits tax to be unveiled for public hearings this month will not exceed 40 per cent, but it may be that high. Probabilities are that the rate will be stepped up in four brackets, instead of the two that Senator LaFollette proposed, but whether the base will be average earnings over three to five years or upon invested capital, or a combination of both, is still unsettled.

Plant amortization legislation is scheduled to move through Congress along with the new tax levy, but there is sharp dispute as to whether both subjects should be in the same bill. The Treasury wants a single measure, whereas some members of Congress favor separation. Preliminary discussions among members of the House Ways and Means and the Senate Finance Committees have revealed wide differences of opinion between the Defense Commission and the Treasury in the matter of amortization of war industry capital. The commission wants legislation that will stimulate investments in new plants and equipment. The Treasury approaches the problem from the standpoint of what revenue a given formula will produce.

There has been no indication that the President's proposal for a five-year amortization will be junked. Most of the time of the informal negotiations has been devoted to consideration of a method of amortization that will protect war industries against loss. Several alternative proposals have been advanced, each designed to accomplish this end in a different manner.

One point bulking large in the preliminary discussion is the question of smaller companies—the group which paid 30 per cent of excess profits taxes collected during the World War. There is general agreement that caution must be observed so that provisions will not operate unfairly. This would be particularly true if the levy were to be based strictly on an average profit base. Large firms with diverse activities have more stabilized profits, whereas many small companies in recent years have shown small profits or actual losses.

The general preliminary discussions indicate a bill designed to raise somewhere between $300,000,000 and $700,000,000 annually. It is realized, however, that no large amount of revenue will accrue for 1940, even if the bill is made retroactive. Committee leaders hoped to get hearings started about Aug. 5, and every effort is being made to have at least a first draft copy of the tax bill ready when the hearings begin. Experience has taught that hearings without a formal copy of the proposed bill are cumbersome and largely useless.

Process Patents Protected

HEREAFTER no one may import "for use, sale, or exchange a product made, produced, processed, or mined under or by means of a process covered by the claims of any unexpired valid U. S. letters patent" except with the permission of the owner of that patent. Thus Congress broadens the Tariff Act of 1930 to give the same protection to process patents as was given ten years ago to product patents.

The inability of certain mining firms in the United States to protect against Russian imports of concentrated phosphate rock prepared under U. S. patents by work abroad was the original occasion for beginning this legislation. In an earlier case the Court of Customs and Patent Appeals had ruled that process patents were not entitled to protection. With the signature of the President on the new act on July 2, this loophole in the patent system is closed.

News "Fines"

Uncle Sam's P.A.—Donald M. Nelson has been named by the President as coordinator of purchases to insure that Army, Navy, and civilian Government buyers do not bid against each other, duplicate purchases, or jam up industry needlessly. But the actual buying is still done in most cases by the same old career units. The only new purchasing activity is by the Defense Commission and new special defense corporations subsidiary to RFC. Those wishing to sell to Army and Navy should get from the Department of Commerce its bulletin "National Defense Procurement" which tells just where the various military buying offices are located.

Bonneville Contract—Secretary Ickes again announces an industrial power contract at Bonneville Dam. The new purchasing agency is Pacific Carbide and Alloys Company which plans immediate plant construction for calcium carbide, with possible later facilities for alloy manufacture.

Illegal Tax Claims—Uncle Sam reminds industrialists who manufacture or merchandise goods that it is illegal to claim that any price increase is caused by taxes unless this is literally and completely true. Any statement exaggerating the tax effect on price may result in either fine or imprisonment.

Passes for Union Work—Employers must not prevent union organizers from reasonable access to unorganized personnel. Ship owners must even give passes for organizers to board vessels in port if that is the only way adequately to reach employees. The NLRB thus rules that denial of such access is illegal interference with collective bargaining.

Quicksilver Exports—The export controls imposed by the Government are urgently needed in a few cases right away. This conclusion is demonstrated to the full satisfaction of Washington in recent experiences on quicksilver. Domestic production would have equaled domestic requirements for this strategic metal if the shipments out of the United States had not been excessive, so officials argue. Export licenses, however, were recently granted for shipment of small lots of quicksilver to Canada.

More Export Controls—Petroleum products and scrap iron and steel are now on the list of goods for which export license must be obtained. This is taken as a very unfriendly act by the Japanese, who expect, probably with justification, that there will come before long almost an embargo on these goods which they so urgently desire.

Devalued Gold—Washington is beginning to take quite seriously the European threat of eliminating gold as the medium of international exchange settlement. It is not believed that Germany can go as far as it threatens in this matter; but there is grave doubt whether the present high price of gold can be continued indefinitely in international affairs unless the controlled economy of the Reich is made (by defeat) a minor part of European trade management. It will be some time, however, before any European influence affects the price which Uncle Sam will pay to the mining industry for new gold.

Military Priority—Already a few commodities and several types of engineering equipment are being controlled by voluntary priority arrangements. There is no official announcement made of this, because the industries affected have cooperated so nicely that no actual regulatory rulings have been necessary. But there is plenty of authority, and a willingness to use it if necessary, whenever required to get a preparedness result promptly.

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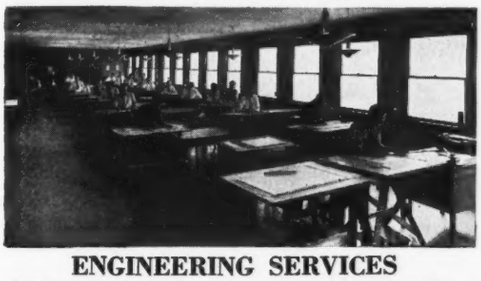

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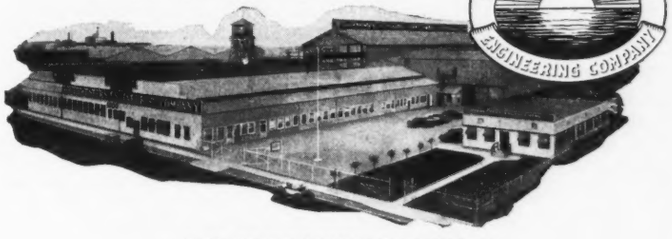

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Development Planned For Several Mines

Company formed to exploit the Atlas Klondyke property—Placer areas near Rico being investigated

▶ The Arivaca Mining Company, Inc., was recently formed by men from Arivaca, Ariz., to operate and develop the Atlas Klondike property, an old gold-silver producer at Ouray. Modern equipment for a 100-ton mill designed by the Denver Equipment Company will be installed. Electric haulage will be utilized underground.

▶ Ward E. Terry, president of the Slide Mines, Inc., in Boulder County, has announced that the company will open a number of its mining properties in the Gold Hill district to leasing on a low royalty basis. Geologists of the company will be available to leasers for guidance and assistance.

▶ Golden Star Mining Company, under the supervision of Fred C. Carstarphen, consulting engineer for the Squaw Gulch Company, Cripple Creek, has just leased the Morning Glory property of the Doctor Jack Pot Co., at Anaconda. Development of the property will probably be the largest new mining project undertaken in the district during the present year.

▶ The Great Western Silver Mines Corporation, operating the Blue Bird group of mines near Nederlands, have found some rich silver ore according to Walter A. Moore, president of the company. Development work will follow the vein, which lies in a nearly horizontal position. New office buildings, compressors, houses and remodeling of the old buildings are in progress, and plans are under way for a new mill.

▶ Messrs. William Reed and M. V. Foglesong and associates have been conducting an exploration program on a large area of ground near Rico. They already have 200 acres of placer ground with options on 500 more acres. Adjoining this property, W. M. Parmley, of Lake County, has secured 200 acres of gold-bearing gravel extending to Scotch Creek. The placer area has been drilled and satisfactory samples have been secured. This new company—the Montelores Mines Company—will erect all necessary buildings as soon as possible. A dragline and bulldozer and other necessary equipment for handling the gravel has been ordered, so that operations can get under way immediately.

▶ About 1,400 tons of dump ore is being milled by the Cameron Gold Mines, Inc., at Cripple Creek, to determine the value of the El Paso dump. If results are satisfactory, a new mill may be erected near the dump.

▶ During the first six months of 1940, the Carlton tunnel was driven a distance of 9,649 ft., or an average of 53 ft. per day. The smallest 24-hour advance was 40 ft. and the maximum 76 ft., the total advance being 16,957 ft. on July 1.

▶ A. E. Reardon, president of Columbus Gold Mines and Fortune Lode Mines Company, Boulder, both of which companies have extensive holdings in the Gold Hill district, plans consolidation of all the properties to form a new company known as Consolidated Mines Company, under the management of Alex McLellan.

▶ The Ute Creek Syndicate, in driving a crosscut tunnel in its property in Clear Creek County, to intersect the Dixie vein, east of its present workings, recently made another strike disclosing ore assaying 3 to 4 oz. gold per ton and 180 oz. silver.

▶ The April Fool shaft of the Fortuna Mining & Milling Company, near Boulder Falls, has been repaired and development work concentrated on the 280-ft. level. The mill, with a capacity of 35 tons daily, is working three shifts and is powered with a diesel electric unit. The flowsheet of the mill, similar to that used by other Boulder County tungsten mills, employs rolls and Bendelari jigs for concentration. W. R. Vidler is in charge of operations.

▶ Guy L. V. Emerson, president, and Count Casa Bayona, vice-president of the Treasure Mountain Gold Mining Company, at Animas Forks, near Silverton, will stay at Silverton this summer and direct the work at the mine. Wilfred Fleming is in charge of operations.

▶ Using a grubstake plan, valuable development progress has been made during the past eleven months on the Pirate molybdenum property near Alma. The present tunnel will be driven to, and through, the big White London porphyry dike, which traverses the property through its entirety and which is said by geologists to be the source of all gold and silver found in or near the famous London fault. Recently two thousand feet of new cable have been placed on the aerial tram; purchase and installation of a power plant with air drills has been made; and mine cars and rails with full equipment for tunneling have been bought. Z. M. Cooper Industries, of Denver, plan a new custom mill at Alma, which when erected will give an outlet for milling this ore. Bert Thompson is superintendent.

American Mining Congress

▶ In announcing the preliminary program for its annual metal mining convention in Colorado Springs, Sept. 16-19, the American Mining Congress called attention to the government's program for acquiring supplies of the vitally needed "strategic" minerals, and pointed out that a full session of the convention will be given over to consideration of the part which minerals play in the present emergency. Another session will study and discuss the effect of World War II on supplies, international movements, domestic markets, prices, etc., of each of the principal metals. Among the speakers will be C. K. Leith, mineral adviser to the National Defense Advisory Commission; Senators Murray of Montana and Key Pittman of Nevada; Colonel Fleming, Wage-Hour Administrator of the United States Department of Labor, and C. S. Ching, United States Rubber Company.

IDAHO

New Tungsten Vein Being Developed

Ima Mines Corporation begins work on area near present tungsten operations—Several good ore strikes reported

▶ Ima Mines Corporation is developing a new tungsten property in the Blue Wing district of Lemhi County, according to President Ben R. Tillery. The development is on the opposite side of the canyon from the company's Ima mine, which is a steady producer. The new vein shows assay returns of 1½ per cent tungsten. The new strike will enable the company to increase its present production to possibly 50 per cent more.

▶ Jerome L. Drumheller, of Spokane, has taken over control of the Idaho Lakeview Mining Company and has awarded a contract for 250 ft. of drift work on the vein. The property, south of Lakeview, has a three-compartment shaft down 1,500 ft., which will be unwatered. A flotation mill of 100 tons' capacity is ready for operation.

▶ James E. White, of Spokane, who has a lease on the Pearl vein of the Whitedelf Mining Company at Clarks Fork, reports discovery of a rich vein of lead-silver ore. At 50-ft. depth the vein shows 24 in. of galena ore that assays 160.8 oz. silver and 13 per cent lead.

▶ Sunshine Consolidated Mining Company reports the discovery of a 2½-ft. vein of silver ore assaying 143 oz. per ton in a diamond-drill hole from the 3,100 level of the Sunshine mine into Consolidated ground. W. M. Yeaman, Yakima, president, said a crosscut tunnel some 1,200 ft. long will be started from the 3,100 level.

▶ An important strike was made at the Liberal King mine, on Pine Creek, west of Kellogg, late in July, according to Manager Henry Weber, of Rose Lake. The vein has been crosscut for 30 ft. with the orebody 10 ft. in width, lead-zinc values predominating. The crosscut had been extended 360 ft. from the bottom of the 1,000-ft. shaft when the ore was encountered.

▶ The south crosscut from the 1,500 level of the Silver Summit shaft, dry ore belt, is nearing its objective, according to Manager Harry Pearson. The crosscut has been extended 1,100 ft.

▶ Sullivan Mining Company, operating the Star mine, in Burke, and the electrolytic zinc plant at Kellogg, is experimenting with a new principle in ore separation at the Star mill. The process, termed the "sink-and-float" process, is under the personal supervision of P. C. Jones, of London, England, representative of Huntington, Heberlein & Company, Ltd. The principal purpose of the experiment is to develop a process of mineral and waste separation underground at the base of operations in order to cheapen the cost of production by removing the bulk of the waste material. The Bunker Hill company, at Kellogg, also has a unit of the sink-and-float process in trial operation.

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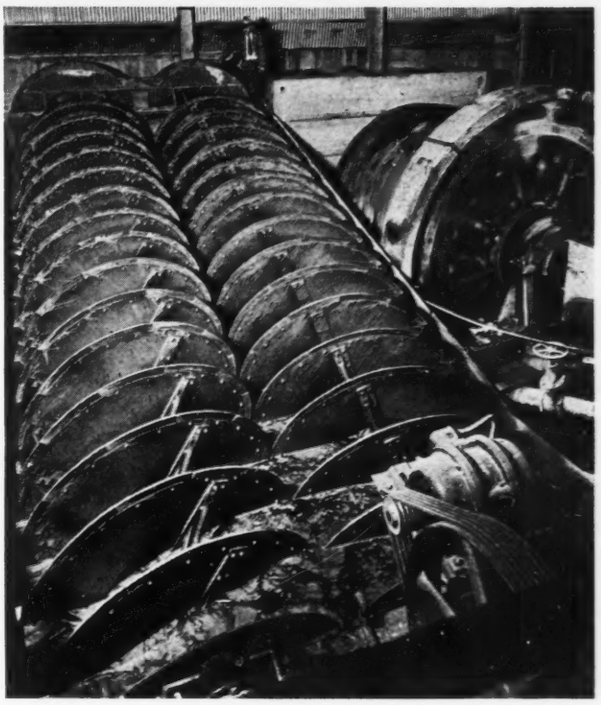

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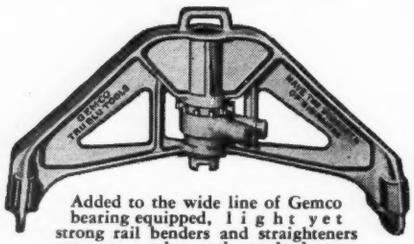

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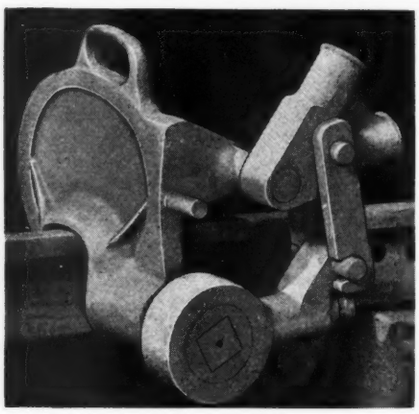

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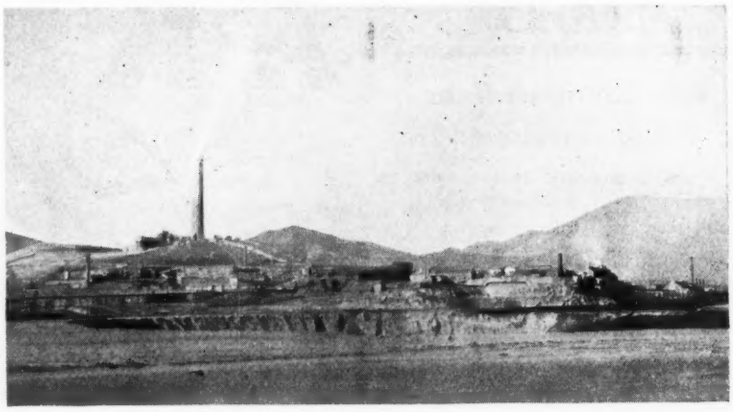


Anaconda Copper Mining Company has plans for the relocation of the converting and casting divisions at its Anaconda smelter so that plant operations will be more compact. A general view of this smelter is shown above

MONTANA

Development Begins at Heleene Mine

Shaft down to 300 ft. and drifting started on the Birdia vein—Good silver ore found in depth at the Flathead mine of Anaconda Copper Mining Company

▶ Work at the Heleene mine by the Hecla Mining Company, of Wallace, Idaho, has progressed rapidly under the management of Earl Hazelwood, of Norris. The shaft has been continued from the 100 level to the 300 level and development started on the Birdia vein. A crosscut is also being driven about 425 ft. north to the Reese vein. The property is in the Norris district near the Boaz mine, which has been a prominent gold producer in recent years. The company is also developing the Black Rock vein, ½ mile from the Heleene shaft.

▶ The new 600 level at the Flathead mine of the Anaconda Copper Mining Company, near Kalispell, is reported to have penetrated sulphide ores of silver of shipping grade. Production under the direction of Emmet Hale, superintendent, is being maintained above 100 tons a day, which is distributed about equally as lead ore, which is shipped to East Helena, and silver ore, which is shipped to the Washoe plant of the Anaconda Copper Mining Company. During the many years that this property has been in operation, water has been hauled 7 miles for all purposes. A program is now under way to develop water by drilling south of the mine. Storage reservoirs, a new change house, and fire connections are being completed.

▶ The Walla Walla Leasing Development Company has begun production from its Silver Cable mine, 8 miles east of Mullan, Idaho, on a trial rate of 150 tons a day. The complex lead, zinc, and silver ore is being trucked to the Crescent mill near Kellogg for treatment. H. Herman Miller, of Wallace, is president and general manager of this new Montana enterprise. Though a considerable amount of development had been completed many years ago, and a good milling grade of complex ore developed, conditions at that time were unfavorable to operation. Development of modern trucking methods, together with road improvements, provided the basis for a decision to reopen the property on a plan of hauling the ore to a mill rather than construction of a plant at the mine.

▶ The Ring interests, of Chicago, are expected to resume development work on the Black Bull group of claims in the Maiden district in the near future.

▶ The Klies Mining Company is treating about 80 tons a day of complex lead-zinc-silver-gold ore in its new mill. About 50 men are employed under the management of George H. Spehn, of Neihart. Tom Pittman, Jr., formerly at the Kendall mine, is superintendent. Also at Neihart, it is reported that the Lexington Mining Company, which operates the Silver Queen property, is employing more than 100 men. The ores are shipped to the East Helena plant of the American Smelting & Refining Company for refining.

▶ Under a recently appointed receivership, Gust Carlson as receiver is resuming a limited development and exploration program at the Spring Hill mine. Production during 1939 totaled nearly 60,000 tons mined and milled. Andrew G. Anderson, of Hibbing, Minn., is president of the company.

Silesian-American Corporation Reports

▶ The Silesian-American Corporation, a concern in which Anaconda Copper Mining Company is a majority stockholder, reports there has been no change in status of the company since the last report January 23, 1940. The zinc properties of its subsidiary, Giesche Spolka Akcyjna, in German-held Poland, are being operated under the direction of a Commissar responsible only to the German Government, and no change is anticipated during the continuation of the war. No income has been received by the company since the beginning of the war.

TRI-STATE

Some Old Zinc Mines Being Rehabilitated

St. Louis Mining & Milling Corporation plans dewatering of several shafts northwest of Joplin—Leasing of properties increasing

▶ St. Louis Mining & Milling Corporation has purchased 540 acres of the du Pont land and leased an additional 500 acres in the old Thoms Station mining field, northwest of Joplin. The corporation, which was organized by Edwin B. Meissner, of St. Louis, president of the St. Louis Car Company and the St. Louis Aircraft Corporation, and his son, Edwin B. Meissner, Jr., will expend $15,000 in revamping the old No. 2 Grasselli mill and the dewatering and reopening of several field shafts on the fee, according to P. E. Tabor, of Joplin, local manager for the corporation.

▶ Several test holes to explore formations several hundred feet below the famous zinc-lead ore-bearing Miami-Picher trough, or fault, were put down recently from the underground workings of the Eagle-Picher Mining & Smelting Company. Although some of the holes showed an ore-bearing structure at a lower depth, the work, which was contracted by the Jones Diamond Drilling Company, of Mineral Wells, Tex., has been discontinued, according to S. S. Clarke, of Miami, general mine superintendent for the Eagle-Picher company.

▶ Settlement has been made of a NLRB case between striking miners and other claimants of the International Union of Mine, Mill and Smelters Workers' Union, a C.I.O. affiliate, and the St. Louis Smelting & Refining Company, involving the reinstatement of 20 men and the payment of $27,500 for back wages and other claims.

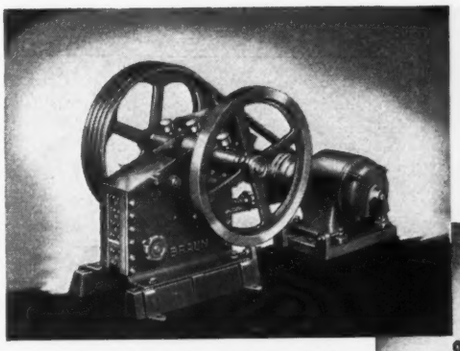
▶ W. L. Turner, of Commerce, district mill contractor, recently completed a 300-ton mill near Lockport, Ky., where the Kentucky Lead Company has developed a rich vein of lead-barytes ore.

▶ Harris Mining Company is reopening the west field shaft on the old Robinson lease of the Kansas Explorations, Inc., northwest of Treece. The mill formerly on the lease was dismantled several months ago. Ore from the lease is being trucked to the mill of the Beck Mining Company, east of Picher.

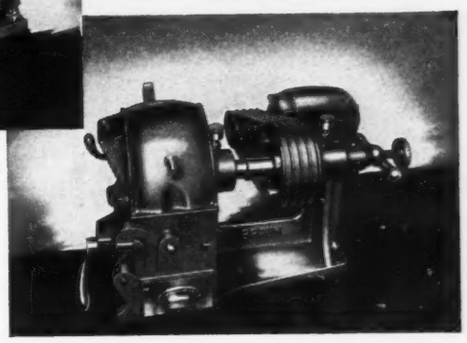
▶ Cameron & Henderson, Inc., has started mining operations at the old Admiralty No. 3 near Century. A large derrick and 500-ton hopper was constructed over the No. 3 shaft, and a 935-ft. railroad spur of the Frisco railroad was extended to the hopper for shipment of ore to the Eagle-Picher Central mill. Approximately 50 men are employed.

▶ The Cedar Mining Company is exploiting a run of lead-zinc ore on the 80-ft. level from an old mill shaft on the O'Hara land in the southeast part of the old Crestline mining field. Frank Hubbard is sinking a new shaft southwest of Badger.

▶ A rich strike of lead ore at a depth of



Braun Chipmunk Crusher with V-Belt Drive



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▶TRI-STATE

22 ft. has been reported by Loren Crowell on the Baldwin land at Aurora. The strike was made near the site of the old Jack Rabbit mill. Several other shallow mining operations of the type that made Aurora a famous mining camp in the nineties are in progress.

▶ Spurgeon Mining Company has completed the installation of a new compressor plant at the company's mill and mines at Spurgeon. A building was erected west of the mill to house the equipment, which includes two 220-cu.ft. Chicago Pneumatic compressors, both operated from the same drive shaft powered by a 75-hp. Fairbanks-Morse oil engine.

▶ Border Lead & Zinc Company has taken a lease on a 40-acre tract of the Henshaw land, south of Baxter Springs, and is making preparations to develop a lower level between two shafts on the lease, according to J. R. Harlin, of Miami, who is in charge of operations.

▶ Operations have been resumed at the Eagle-Picher American mill at Oronogo, following a month's shutdown in July while overburden was removed by the Oronogo Mutual Mining Company from its open-pit lead-zinc mine west of the mill.

▶ Two fires causing major damage to mining properties in the Tri-State district occurred during June. On June 2, damage estimated at $7,500 was caused by fire when the mill derrick and hopper were virtually destroyed at the Rialto mine, south of Picher. The fire also destroyed a portion of a tailings conveyor, which caused suspension of tailings re-treatment operations at the Rialto plant for several days. After the restoration of operations at the tailing plant, the mine derrick and 400-ton hopper were rebuilt. The sampling plant and adjoining conveyors at the Gordon central mill of the Federal Mining & Smelting Company were destroyed by a fire on the last day of June. Work of rebuilding the plant and the installation of new equipment was rushed to completion within a ten-day period, as mining and milling operations of the company, employing a large crew of men, were halted by the fire.

MICHIGAN

White Pine Copper Mine Being Dewatered

Copper Range Company to sample disseminated copper deposit to determine best method for ore treatment—Freda tailings plant operating near capacity

▶ Dewatering the old White Pine mine, owned by the Copper Range Company, is in progress preparatory to the removal of adequate samples from old workings in No. 4 shaft for test purposes. Actual mill runs of the best methods found will be made. Copper at this property is said to be plentiful but disseminated and a special method of treatment is believed necessary. The property formerly was owned by Calumet & Hecla.

▶ The Copper Range Company is operating its tailings recovery plant at the Freda mill full time, and good results are being obtained. Operation of this plant is made possible by adequate dump hydro-electric power. Development work in the Champion mine continues to open ground carrying copper ore of satisfactory grade but within narrowing limits. Production from new territory in the Globe property is expected to show a substantial improvement over that of last year.

▶ A $40,000,000 increase in 1939, half again as much as was produced in 1938, is revealed in final 1939 production figures for the mineral industries of Michigan, compiled by the Geological Survey division of the Department of Conservation. Greatest gain since the beginning of the war-time upswing which is now boosting 1940 production was made in iron ore, of which 11,238,605 tons was shipped in 1939, against 4,092,902 tons in the previous year. Copper output increased from 75,281,469 to 89,402,464 lb. Salt production totaled 2,354,333 barrels and limestone production increased from 7,522,830 to 12,672,114 tons.

IRON COUNTRY

Production of Iron Ore Approaching Capacity

Monthly shipments currently estimated to be about 10,000,000 tons—Hill-Annex mine threatened by labor strike

▶ Consumption of Lake Superior iron ore during June was 5,212,699 gross tons, compared with 4,566,200 tons the previous month. Consumption so far this year totals 27,332,666 tons, against 16,970,886 for the same period in 1939.

▶ Shipments of iron ore from the Lake Superior district are running about 10,000,000 tons per month and every indication points to better than a 60,000,000-ton year. All properties are virtually operating at capacity and railroads have all equipment in operation to handle greater tonnage.

▶ The Hill-Annex mine, operated by the Inter-State Iron Company (a subsidiary of the Jones & Laughlin Steel Corporation) was recently threatened with a labor strike. The C.I.O. has been active at the mine the last two years, but has been unable to gain recognition as the sole bargaining agent. Recently the union served notice that unless it were recognized, a strike would be called. A law, however, passed by the last Legislature and signed by Governor Stassen, stated a 30-day breathing period was necessary so that both sides could be heard. While Governor Stassen was at the Republican Convention, the Lieutenant Governor acted in his place, and the C.I.O. attempted to show that he did not have this power. The union is also suing the Governor and the Finding Commission in order to prove this law unconstitutional. The Attorney-General ruled out these two complaints and Gov-

ernor Stassen will publish the findings of the Commission and it is reported he can see no reason for a strike. Several conferences have been held between the company and the union and a settlement was recently made.

▶ The M. A. Hanna Company has ordered five 15-ton Euclid trucks to operate in the Mesabi Chief mine at Keewatin, Minn.

▶ Mesaba-Cliffs Mining Company has received three additional Euclid trucks of 15-ton capacity for use at the Holman-Cliffs mine, at Taconite, Minn.

▶ The Judd mine, at Taconite, Minn., operated by the Charleson Mining Company, is now operating its jig plant.

▶ Oliver Iron Mining Company has received two new 1,000-hp. diesel electric locomotives for use in its mines in the Hibbing district.

▶ Two drills were installed recently by the S. E. Aitkins Company, Duluth, Minn., at Trommald, Minn., on the Cuyuna range. These drills will be used to prospect ore for the Manganiferous Iron Company operated by Butler Brothers.

PHILIPPINES

Gold and Base-Metal Output Increasing

Shortage of vessels hinders exports of ores and concentrates and prevents importations of supplies—Most mining companies accumulated and stored needed equipment during 1939

▶ Gold production is continuing to rise in the Philippines. Total output for the first half of 1940 was valued at 37,000,000 pesos, against 33,000,000 pesos for the same period in 1939. An increase of around one million pesos in bullion production by Masbate Consolidated, and the output of several new operations—Capsay, Mayon Mining, Benquet Goldfields, Paracale National—have brought about this advance, which has established another all-time record for a six-month period.

▶ Dividends paid by the mining and mine management companies from half-year profits declined, the amount being 8,234,892 pesos; the 1939 total dividends were 24,021,290 pesos. This decline, however, does not represent lower operating profits; practically every company in the Islands has found it wise to carry equipment, parts, and supplies for eighteen months in advance, and surplus funds have been diverted to this channel instead of being made available for dividends. The increasing difficulty of securing shipping space and the likelihood of higher prices in the near future have justified this policy.

▶ Base-metal production is being handicapped considerably by a shortage of shipping space. A renewed demand for chrome ore from the United States is reviving interest in the Masinloc field (which is now the only large source of chrome in the Islands), and shipments are being made as regularly as ships are

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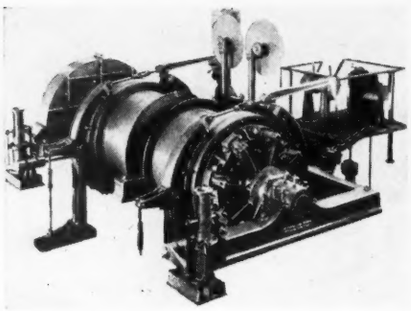

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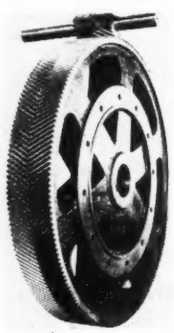

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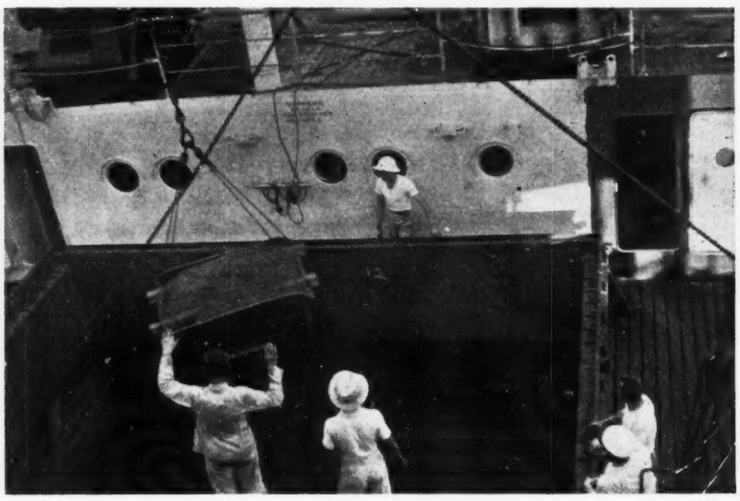

Loading copper concentrate at San Fernando, Philippine Islands, for shipment to Japan. This concentrate, produced at Lepanto Consolidated, is trucked through Baguio to the coast for shipment. About 1,500 tons a month is leaving the Islands.

▶PHILIPPINES

available. Iron ore is flowing in a steady stream to Japan—the amount being limited to some extent by a shortage of bottoms.

▶Both gold and base-metal mining operations have established new all-time high production records for the first half of 1940, and if the present rate is continued, the year will be another record-breaker for the industry. Increased demands from Japan for base metals, and a continuation of the steady growth of the past five years in gold mining, have caused this situation. There is every reason to expect that the gold-mining industry will continue its growth; the base-metal industry, dependent as it is upon Japan, seems likely to fluctuate. War conditions are not being felt seriously in the Islands as yet except in a shortage of vessels, both for the export of ores and for the importation of machinery and supplies. Most machinery and supply houses, however, anticipated the situation long enough ago to lay in suitable stocks to carry them over for some time.

▶An important aspect of the war abroad, as far as American manufacturers are concerned, is the curtailment of trade between the Philippines and foreign countries. Though much of the machinery and supplies used in Philippine mining plants (as well as in industry in general) comes from the United States, large amounts of heavy machinery, chemicals, and manufactured goods have been exported from Germany, France, Belgium, Italy, Spain, and England. English suppliers have been able to keep a flow of goods coming so far—but with delivery dates much delayed and very uncertain. Trade with the other European countries has been cut off almost entirely. Naturally, Philip-

1940 Base-Metal Production

(January – June inclusive)

	Tons, Ore	Value, Pesos
Iron		
Philippine iron mines	292,861	1,358,773.40
Samar Mining Company	186,650	856,831.50
Gold Star Mining Company	52,447	235,416.35
Agusan (insular mine operators)	90,483	407,173.00
Totals	622,441	2,858,194.25
Chromite		
Acoje Mining Company	20,658	1,063,130.00
Filipinas Mining Company	8,483	169,670.00
Consolidated Mines	48,800	685,400.00
Zambales Chromite	7,015	121,035.51
Dinagat Mines	2,000	.....
Totals	86,956	2,039,235.51
Copper		
Lepanto Consolidated Mining Company	73,115	1,140,225.17
Hixbar Mining Company	9,955	293,553.85
Totals	83,070	1,433,779.02
Manganese		
Cia. Minera	2,226	61,753.00
Amalgamated Minerals	8,800	264,000.00
Mine Factors	36,225	358,758.56
Totals	47,251	684,511.56

pine buyers are turning their attention to the United States, where similar products, although often higher priced, can be obtained. Thus American manufacturers have an opportunity of increasing their foothold in the Islands.

▶ Little construction is going on; none of the older operators are undertaking expansion at this time, and several new plants started last year are nearing completion. The Batong Buhay 100-ton plant north of Baguio is expected to begin operations in August. All mill machinery and equipment purchased from the Tumbaga Mine (in the Paracale district) is on the mill site, and the three diesel engines for the power plant have arrived.

▶ Lepanto Consolidated (Nielson) is completing the installation of a 50-ton Mace smelter at its plant in Mankayan. It will be blown in during August. This smelter will be the second Mace unit in the Philippines (the Marsman smelter, at Mambulao, has been in successful operation since 1937) and is expected to cut the Lepanto operating costs considerably. Lepanto now ships its concentrate direct to Japan, but hopes to be able to develop an American market for its smelter products.

▶ The newest plant to join the ranks of the producers is that of the Antipolo Mining Company, which was started in April. The plant is of 50 tons' daily capacity, the flowsheet being a combination cyanidation-flotation process. The mine is near Manila, in Batangas province, and is the first to be opened in that area. Recovery during May averaged 8.91 pesos per ton, mill heads being 11.50 pesos.

CANADA

Gold Mines Drive for Greater Output

Properties with sufficient ore reserves begin to expand production—Mercury plant in British Columbia, doubling capacity

▶ A delegation of nineteen leading representatives of the Canadian mining industry recently conferred at Ottawa with the Hon. J. L. Illey, Minister of Finance, for the purpose of discussing war-time problems of gold production. The relation of recruiting to mine employment was adjusted to allow eligible men to receive military training without disrupting mine schedules. Gold mining was recognized as an essential war industry and was assured the full cooperation of operators and the various departments of the Federal Government. The following statement was recently made by the Minister of National Defence, Col. J. L. Ralston: "Further extension of gold output is a most immediate and important means at hand for directly augmenting our supplies of foreign exchange."

▶ The process of stepping up production is noticeable in reports for second-quarter output issued by fourteen mines, eleven of them in Ontario. The upward trend is referred to in statements from various mine officials, and is being

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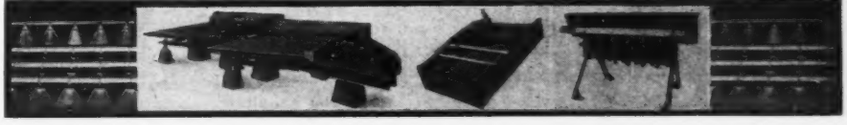

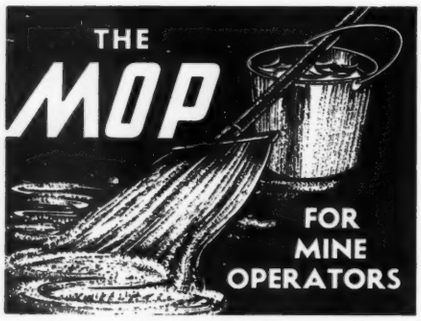

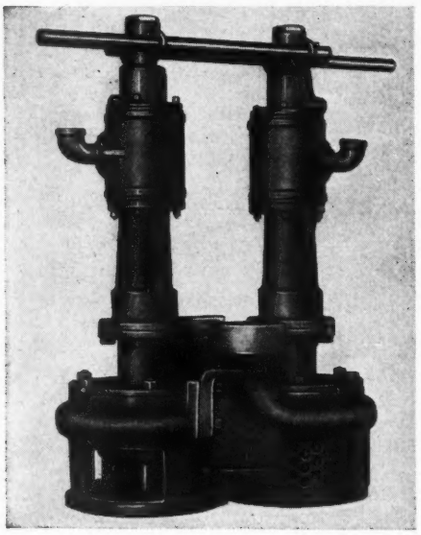

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▶CANADA

applied generally to all mines where ore reserves permit.

Quebec

▶ Sigma Mines is a leader in stimulating the output of bullion, following a decision of the directors to jump production 10 per cent, in the national interest. A sorting plant is being installed to provide an additional 100 tons a day and the mill rate is to be raised to 1,000 tons to give an estimated annual gold recovery of $3,000,000.

▶Malartic Gold Fields plans to double mill capacity before the end of the year, beginning with an extra 100 tons a day in August. J. P. Norrie, vice-president, reports the discovery of a new orebody in shaft sinking at a depth of 645 ft. R. Halet is mine manager.

Ontario

▶ Macleod-Cockshutt Gold Mines has been successful in outlining a large new orebody in the north zone. Discovered in June by diamond drilling, the ore has been extended by further drilling for a 400-ft. length. Drifting on the 500-ft. level has established a cut grade of $10 a ton, with the block making an estimated 850 tons to the vertical foot. Orebodies formerly known 1,200 ft. to the east in the same zone failed to open up as readily as this most recently located structure, which still has both ends open. Mine production is being held at an average rate of 650 tons daily.

▶ Hoyle Gold Mines, adjoining Pamour in the east Porcupine section, plans to start mill construction soon, the initial capacity to be at least 400 tons a day. Estimated mill heads are $5.60 a ton, which would be lowered to the mine average of $4.34 when production is advanced to 1,000 tons a day. Hoyle is controlled by Ventures Limited, which agrees to finance 60 per cent of mill costs through two subsidiaries, Coniaurum and Matachewan Consolidated.

▶ Coming into production six months ago, Aunor Gold Mines has increased the mill rate to 400 tons a day, accompanied by a noteworthy improvement in grade. A block of new levels down to 1,500 ft. is being explored and may lead to further mill enlargement. Preliminary diamond drilling below 1,400 ft. indicated a considerable increase in widths which may represent a convergence of the narrow veins above, as is found on neighboring properties.

▶ At Magnet Consolidated Mines ore reserves are expected to be doubled as a result of establishing the downward extension of the high-grade oreshoot from 780 to 1,080 ft. An increase in production to 150 tons a day will soon be made, and secondary crushing equipment is now being installed.

British Columbia

▶ Reduction of the quarterly dividend of Privateer Mines, Ltd., at Zeballos, from the previous rate of 5c. to 3c. per

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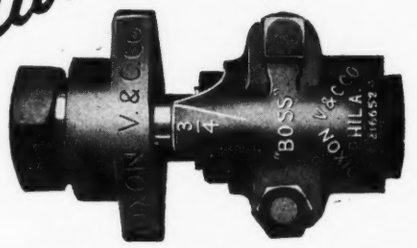

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share, is prompted, not by a decrease in earnings, but solely for the purpose of building up surplus and making provision for increased war-time taxation, company directors state. There is also the object of assuring that ample funds will be available for development of the Proserpine property, in the Cariboo district, if such development is approved by company engineers and the option is proceeded with.

▶ Granby Consolidated Mining, Smelting & Power Company has decided to conserve its cash resources because of the possibility that it may require a substantial sum for construction of its own smelting and converting plant, near Princeton, in the Similkameen district. War conditions and resultant increase in taxation are another factor in determining the company's policy in that respect. Disbursement for the current quarter will thus be only 15c., though earnings have amply justified a payment of 25c. per share. An extensive construction program, including enlargement of the Granby concentrator and power plant as well as erection of facilities for storing concentrates, has involved capital expenditures of approximately $325,000.

▶ Hon. W. J. Asselstine, B.C. Minister of Mines, subsequent to a tour of the Omineca district, announced that Consolidated Smelters will double the capacity of the present 50-ton mill at its Pinchi Lake mercury property. The minister expects the cinnabar development to produce above $750,000 during its first year of operation. The mine's first shipment of mercury—400 75-lb. flasks—was recently flown from the reduction plant to railhead for shipment to Montreal. This represents one month's production, reduction of cinnabar ore having begun June 10 of this year.

▶ In the Bridge River area, the Empire shaft of Bralorne Mines, Ltd., has been sunk to a point 40 ft. below the 17th level, according to Dr. Howard James, managing director. Sinking operations will continue until the 20th level is reached, which is the present depth of the Crown shaft. From the Crown shaft development on the 20th level is said to be proceeding satisfactorily. Present sinking operations on the Empire shaft are being conducted as a result of "scout" drillholes which indicated continuance of the main Bralorne veins to the 20th level.

▶ Gold Belt Mining Company, Ltd., in the Nelson district, reports a definite increase in ore reserves as at July 1 compared with March 31, 1940, when the company's fiscal year terminated. According to Robert Livermore, executive of North American Mines, Boston, and consulting engineer of Gold Belt, recent underground work at the property has resulted in the clarifying by geological study of the relationship of the veins opened by the 1850 tunnel to those in the old workings above the 600 level.

▶ Since assuming control of Spud Valley Gold Mines Ltd., Zeballos, on April 1st, 1939, the present Spud Valley company has liquidated from earnings a purchase obligation of $350,000 and paid its first dividend on July 10th.

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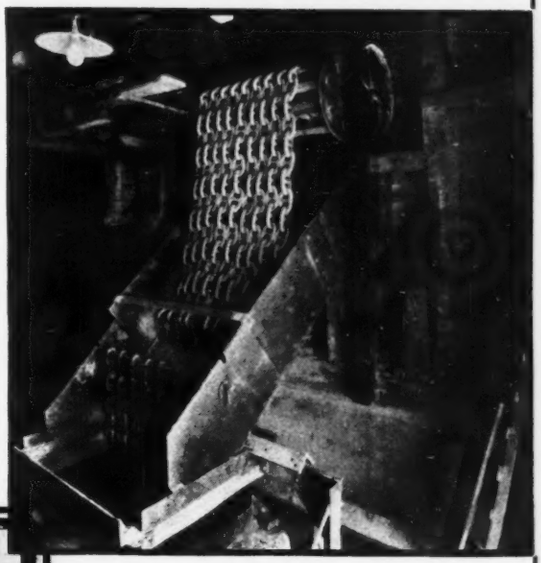

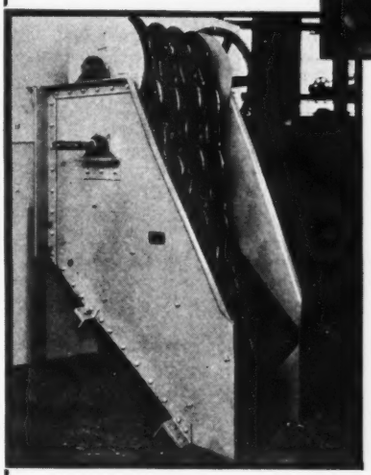

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YUGOSLAVIA

Germany to Gain in Copper Imports

Fall of France simplifies objective of Nazis to obtain major copper output from French-owned Bor Copper Mines in Serbia

▶ The Bor Mining Company, in Yugoslavia, owned by French capital, is reported to have given German interests full access to the output from its mines. The volume of copper that will be shipped into Germany, however, is pending arrangements between the mining company and the Yugoslavia Metal and Ore Control Board. In 1939 the Bor copper mines produced 45,920 short tons of copper, against 46,288 tons in 1938. A small percentage of the output of the British controlled Trepca lead and zinc mines, near Skoplje, is being also sold to Germany through the Yugoslavia control board.

▶ At a recent meeting of Selection Trust, Mr. Beatty said the Trepca Mines are operating at normal capacity and that the lead smelter at Zvecan erected by Topionica Olova (a wholly owned subsidiary of Trepca) has been completed and is now producing refined lead at the rate of 1,200 tons monthly.

AFRICA

Maximum Gold Output Is Objective Sought

Ambition to win and pay for war is promoting efficiency in gold mines—Another reef reported found in Western Rand

▶ Advices from all gold-mining districts in Africa tell of maximum productive activities. The supply of native labor is plentiful. Practically all the plant expansion started a year or two ago is now in operation. The ambition to help pay for and win the war is making labor exceptionally efficient. High gold prices make possible the treatment of lower-grade ore, so old stopes are being reworked and the reserves of the mines not exhausted. But despite the slightly diminished yield in pennyweights per ton, new high records of production are being set up.

▶ Witwatersrand's gold production in May (27 working days) was 1,186,053 oz., valued at £9,962,929. It was 15,300 oz. and £1,942,491 of value above the previous highest record.

▶ The higher price for gold is not manna from heaven for the mining companies, however. It is merely helping them to pay increased taxes. P. M. Anderson, chairman of Geduld Propriety Mines, has explained the relation of these two factors to his company by pointing out that the higher price for gold would have given his company, in the first quarter of this year, an increased working profit of £55,500, but taxes increased by £58,200.

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PAE

► Grootvlei Propriety Mines has ordered the equipment for an increase in mill capacity to 120,000 tons monthly. The previous increase to 80,000 tons is giving better results than expected, 97,000 tons having been put through in May. Ore reserves were increased 40 per cent last year to 5,250,000 tons averaging 5.5 dwt., which is the same as a year ago.

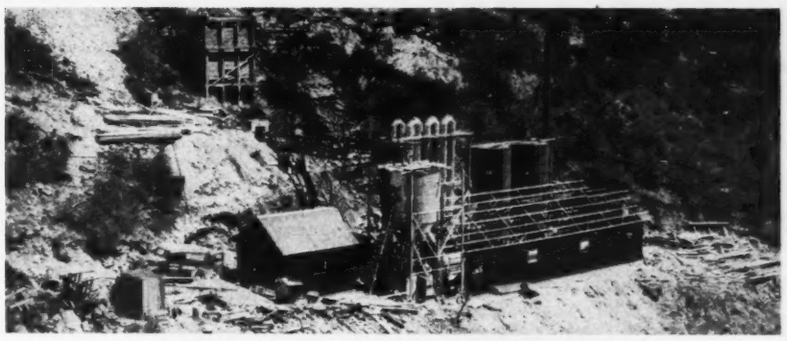
► In its first full year of productive operations Van Dyk Consolidated Mines milled 1,026,600 tons of ore and made a working profit of £664,550, an increase of nearly £500,000. The yield of gold increased and working costs were reduced 5d. per ton. Ore reserves were increased 15 per cent to 2,600,000 tons averaging 5.6dwt. over 40 in. The higher price of gold makes it possible to increase this total developed tonnage by about 35 per cent.

► At the meeting of Union Corporation, which owns considerable interests in many African gold, diamond, and copper mining undertakings, it was stated that the drilling in the Western Holdings property has proved the presence of the Upper Elsburg reef zone of the Witwatersrand system, and that two of the reefs in this zone appear to be of considerable promise. It was further stated that Roan Antelope and Rhodesian Selection Trust (in which it is interested through direct holdings and through its interest in Selection Trust, Ltd.) are earning good profits though selling their copper to the government for much less than the world price, and that relief is being sought from retroactive and double taxation.

► At the Selection Trust meeting, A. Chester Beatty said the Roan Antelope and Mufulira mines have largely increased their activities since the outbreak of war, and now are working seven days a week to produce for the British Government every ton of copper possible.

► A statement by S. S. Taylor, chairman, at the annual meeting indicates that Rhodesia Broken Hill Development Company's mining position has greatly improved. As a result of the continued campaign of diamond drilling Dr. Bancroft had reported the indicated reserves of ore as follows: 2,400,000 tons of oxides averaging in percentages 23.5 per cent zinc, 6.7 per cent lead, and 0.83 per cent vanadium; sulphide, 1,600,000 tons averaging 36.7 per cent zinc, 23.9 per cent lead, and 18.2 per cent sulphur. Though this does not exhaust the possibilities of further ore being found, the amount of drilling will be reduced for the present. Additions are being made to the acid and leaching plants, a vanadium flotation plant is to be erected and additional hydro-electric power is to be developed. Profit for last year was £207,750, an increase of £42,000. It is estimated that plant expansion and development can be paid for out of profits.

► The head office of Union Minière du Haut-Katanga is now established outside of Belgium, it was stated at the annual meeting of Zambesia Exploring Company. Union Minière is reported to be operating continuously and finding a ready market for its copper.



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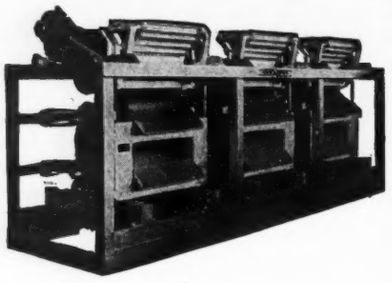

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AUSTRALIA

High-Cost Gold Producers Exempt From Tax

Government seeks to ease burden in order to encourage greater production of gold—Underground prospecting determines large tonnage of iron ore on Eyre Peninsula in South Australia

▶ The Gold Mining Encouragement Act, recently passed by the Commonwealth Parliament, seeks to mitigate any hardships which the existing gold tax may impose on marginal producers. It provides that remission of tax will be made to high-cost producers, the effect being that those whose costs exceed approximately £9 Australian currency per ounce will be exempt from the tax.

▶ Iron ore produced by the Broken Hill Proprietary Company from its quarries on Eyre Peninsula during 1939 totaled 2,570,989 tons. The ore reserves in sight are extensive, but underground prospecting in progress is indicating the existence of considerably larger tonnages.

Western Australia

▶ North Kalgurli (1912), Ltd., Kalgoorlie, has intersected, in diamond drilling from No. 8 level north drive, Union Jack shaft, what appears to be a big body of ore in virgin country. The average assay was 6.34 dwt. per ton over a drill length of 43 ft.

▶ Paringa Mining & Exploration Company, Kalgoorlie, reports having picked up, at a depth of 200 ft. on its North Kalgurli Central lease, the southern extension of the old Eclipse main lode, worked in the early days in the Eclipse lease, now owned by North Kalgurli (1912), Ltd. Where encountered, the lode varies in width from 7 to 20 ft., and averages 5 dwt. in value.

▶ Gold production of the State for the five months to May 31 was 497,424 oz., an increase of 24,332 oz. compared with the corresponding period of 1939.

Victoria

▶ The pontoon of the large dredge under construction for Harrietville (Tronoh), Ltd., Harrietville, was floated on June 1. It is expected that the dredge, the rated capacity of which is to be 350,000 cu.yd. monthly, will be working within twelve months. The area contains 100,000,000 cu.yd. of wash averaging 1.9 grains per cubic yard.

▶ Dump re-treatment at Bendigo is yielding 10,000 oz. of gold annually, the average recovery being 11 grains per ton. Employment is afforded to between 250 and 300 men.

▶ Tarnagulla Great Western, N. L., recently formed to take over a promising prospect being operated by a syndicate at Tarnagulla, has had a first crushing of 45 tons for 56 oz. gold. Tailings assayed 4.6 dwt. per ton.

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Tasmania

The milling plant of Montana Silver Lead, N. L., Zeehan, has commenced operations, and is at present working one shift daily. Employing flotation, the mill has a capacity of 25 tons per shift, but the immediate aim is to treat 1,000 tons of ore monthly.

▶ Briseis Consolidated, N. L., Derby. sluiced 60,000 cu.yd. of gravel during May for a return of 65 tons tin concentrate, the best monthly result since the company commenced operations. The yield was valued at £A13,540 and working profit was £A9280.

New South Wales

▶ The Zinc Corporation, Ltd., Broken Hill, reports a net profit for 1939 of £142,575 sterling, as compared with £184,422 for the previous year, the drop being attributed to increased mining and milling costs and the fall in metal prices during the year. The full benefit of the new shaft, mill, and underground equipment was not reflected in the year's results, as these improvements were put into service only during the period.

▶ North Broken Hill, Ltd., has demonstrated in diamond-drilling operations that an appreciable quantity of payable ore still exists at the 500-ft. level of the mine, with prospects of continuance to the 700-ft. level. The company's present shaft-sinking program has been completed with the sinking of No. 2 shaft to a depth of 2,773 ft.

▶ Lucknow Golden Valley, Lucknow, after reconditioning an existing shaft and installing winding equipment, has commenced exploration underground, and has discovered at the 200-ft. level a shoot of rich sulphide ore, carrying arsenical pyrites, and 12 ft. wide. The discovery is in virgin ground.

Queensland

▶ Manganese Mining Corporation, Pty., Ltd., formed to acquire a group of manganese mines near Imbil, in the Gympie district, has commenced production, and is shipping ore to the steelworks at Newcastle, N.S.W.

▶ The water supply position at Mount Morgan, which had been causing some concern, has been eased by a fall of 535 points of rain, which has practically filled all the dams. The rain interfered with the opencut operations, however, causing a diminution of the tonnage of ore mined.

New Guinea

▶ Gold bullion production of the Morobe gold field for the month of April was 59,880 oz., valued at £A407,533. Production for the ten months since July 1, 1939, is valued at £A2,412,599, a record for the field.

Fiji

▶ An important development has occurred at the Emperor mine, in the Tavua gold field, where on the No. 3 level the 1420 west crosscut has encountered the Regent lode. Where intersected the lode was 30 in. wide and assayed 14 dwt.

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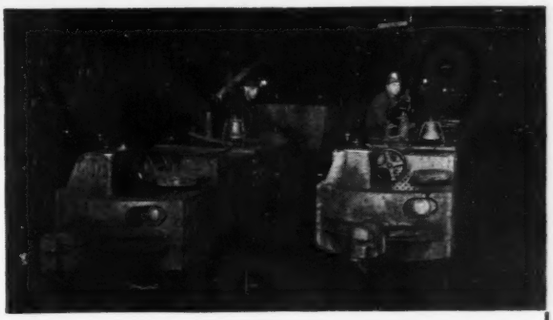

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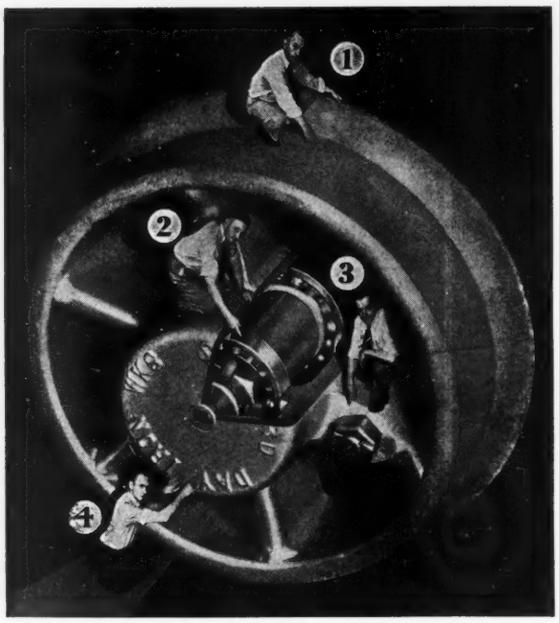

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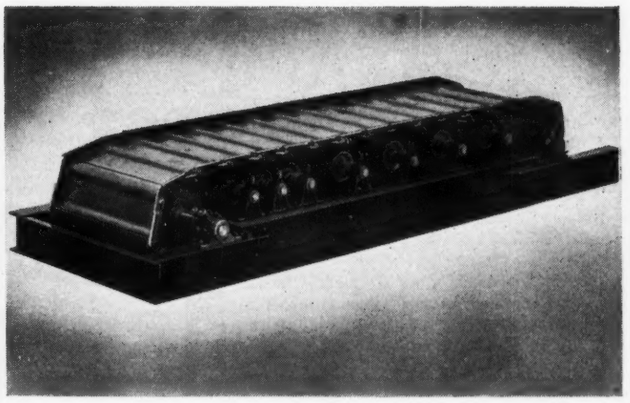

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The ROBINS-ORO Feeders are designed and built for the most severe service. The Manganese Steel Feeder Pans are integral with the chain . . . not bolted to it. This means fewer parts and less maintenance. The special high grade manganese steel used for pans, sprocket teeth and supporting rollers withstands abrasion from the hardest ore. These Feeders are handling large tonnages of heavy ore in big sizes in the most efficient metal mines. Made in sizes and capacities to meet all conditions.

ROBINS-ORO Feeders are fully described in a new bulletin. Send for your copy today.

ROBINS MAKES: Belt Conveyors, Bucket Elevators, all types of Feeders, Vibrating Screens, Screen Cloth, Bin Gates, Ore Bedding and Reclaiming Systems and all their parts and accessories.

MATERIAL HANDLING ROBINS EQUIPMENT

ROBINS CONVEYING BELT COMPANY
PASSAIC, NEW JERSEY
Offices in principal cities

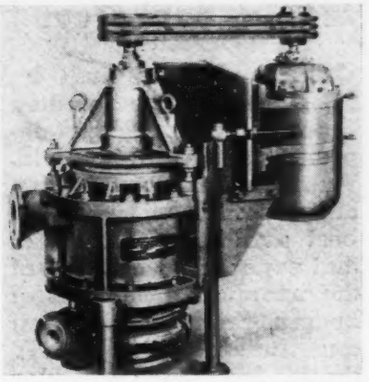
EQUIPMENT NEWS

Light-weight Rock Drill

MANUFACTURERS serving the mining industry are constantly offering types of equipment that provide the mine operator with greater efficiency, and coincident with this objective is the desire to reduce heavy work for the miner. Considerable research and thought are being given to design of rock drills in which the use of strong light-weight alloys is increasing, all contributing to greater ease in the handling of rock drills and other equipment. After three years of investigation and five redesigns, the Ingersoll-Rand Company, Phillipsburg, N. J., announces a new 116-lb. rock drill known as the R-58. This light-weight machine is said to assume a natural drilling position because the location of center of gravity of the machines makes this possible. Other features that contribute to easy handling are the feed leg control, which permits many fine variations in feeding power; a short over-all height of only 59 in., which prevents the drill from being top heavy and its use in restricted stopes as well as large stopes, and a plate-type throttle-valve, which provides half throttle position for "collaring" holes. The exhaust is placed on the opposite side of the cylinder from the operating controls, thereby directing the exhaust air and stray water away from the operator. Another important feature of this drilling unit is the automatic chuck-cleaning system, which keeps the drill free from cuttings and water and at the same time provides ample lubrication for all front-head bearing surfaces. The drill is also equipped with a new type valve.

Packless Pump

A PACKLESS PUMP, as its name implies, requiring no packing, having no stuffing box, no gland, and no liquid or mechanical seal, is announced by the Allen-Sherman-Hoff Company, Philadelphia, Pa. All parts are said to have the strength of steel, but those in contact with the solution being pumped are totally covered with the company's resilient Maximix rubber or neoprene for corrosion or abrasion resistance. Absence of a gland seal in this new unit avoids all leakage and waste of valuable solution. The pump is a positive feed centrifugal unit consisting primarily of a

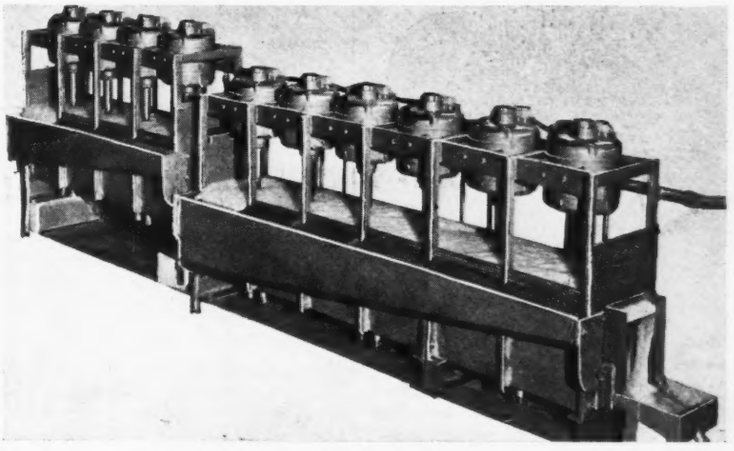


rubber- or neoprene-lined feed tank with the pump itself directly beneath. The pump shell is lined with rubber and the impeller consists of a metal frame around which the rubber compound is molded. The design of this new pumping unit provides for operation with the feed equal to or less than the full capacity of the pump, as regulated by the variable pitch, V-belt drive. This makes it possible to pump under widely fluctuating conditions. Various sizes available.

Counter Froth Flow Flotation System

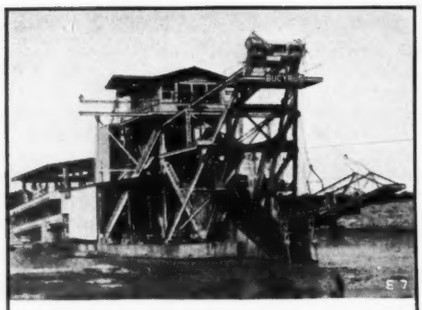
THE BOOTH-THOMPSON Metallurgical Division of the Galigher Company, Salt Lake City, Utah, announces the development of a new flotation system called the counter froth flow system. This method of flotation is said to find an ideal adoption in a new design of the company's agitair flotation machine. The accompanying photograph illustrates a ten-cell "pilot plant" agitair flotation machine utilizing the counter froth flow system. The lower six cells are utilized as roughers and the froth discharging from the No. 1 cell and pumped to the head of the 4 cell cleaner also utilizes the countercurrent froth flow system. Finished concentrates are removed from the No. 1 cell of the cleaning section and the tails join the feed to the six-cell rougher unit.

Essentially, this method of treatment provides for removal of froth at one or more points, usually the head or No. 1 cell in a given series. In operation the feed to the flotation machine enters the No. 1 flotation cell and progresses through a series of cells to final discharge of tailings at the end of the machine. The froth containing the valuable minerals progresses from the last



cell towards the head end and finally to the No. 1 cell, where it is discharged in the form of finished or partly finished concentrates. The froth can be discharged either to a cleaning flotation machine, which may or may not utilize the counter froth flow principle, or it may be discharged as a finished concentrate. In this system of flotation, the froth takes a direction of flow in the opposite direction to that of the travel of the main body of pulp, due to the fact that in any flotation machine that provides for an abundance of air with positive control of each flotation cell unit, a greater quantity of air can be used on the tailings end of the flotation machine and with the use of progressively smaller amounts as the head end of a bank of flotation machines is reached.

The company's new method is said to allow the following advantages over ordinary flotation methods: (1) Makes a higher grade rougher concentrate; (2) Eliminates or decreases amount of middling return; (3) Improves metallurgi-

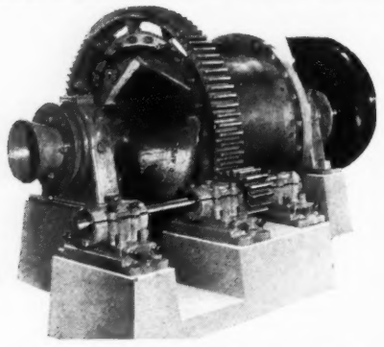


Placer Dredges with a Background

Placer dredges built by Bucyrus-Erie have operated successfully in placer deposits all over the world. Your dredge, built by Bucyrus-Erie, will be the best available because of that experience, because of the unequalled facilities of Bucyrus-Erie for designing and building the RIGHT dredge for YOUR particular job. Ask for full information.

BUCYRUS-ERIE COMPANY
SOUTH MILWAUKEE, WISCONSIN, U. S. A.

DESIGNED AND BUILT TO REDUCE GRINDING COST



Williamson Mills, like the above 3½′ x 4′, are specially designed and built to assure modern milling plants efficient grinding and low cost operation—less power, ball and liner consumption per ton of ore ground—for which Williamson Mills are recognized the world over.

"It's the shape of the drum that does it."

Obtainable with overflow or grate discharge in sizes up to 10½′ dia.

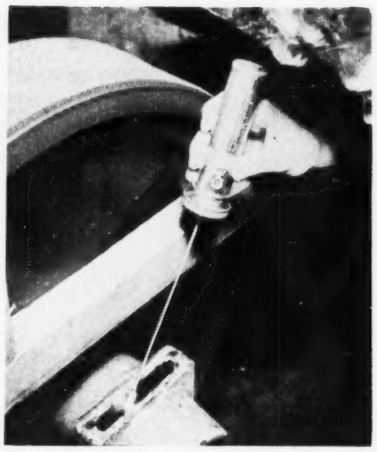
Let us help you solve your grinding problem.

WILLIAMSON COMPANY
582 Market St. San Francisco, Calif.

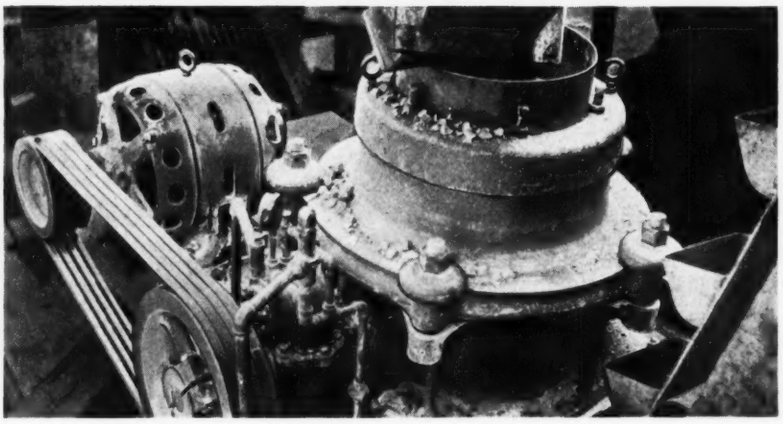
cal efficiency; (4) Increases metallurgical capacity of flotation machines; (5) Eliminates or decreases amount of spray or wash water used in launders; (6) Reduces floor space requirements; (7) Allows direct filtration of flotation concentrates; (8) Allows for simplicity in cleaning and recleaning operations; (9) Reduces quantity of required frothing reagents.

Asbestos Sheet Packing

FOLLOWING SEVERAL YEARS' research, Green, Tweed & Company, 101 Park Ave., New York, N. Y., announce a new compressed asbestos sheet packing. It is made of long fiber asbestos combined with strong bonding agents and is produced in uniform thicknesses. The manufacturer offers it as an all-purpose flange and joint packing for superheated and saturated steam at high pressures and temperatures, also for packing against air, gases and oils.

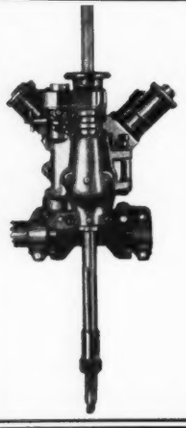


Projecting light into difficult places in mines as well as machine shops is claimed for this flashlight bulb extension made by the Sierra Aircraft Company, Sierra Madre, Calif.



New Crusher

SMITH ENGINEERING WORKS, Milwaukee, Wis. announces its recent development the "intercone" crusher for the secondary and fine crushing field, requiring little headroom. It is a high-speed reduction crusher having a conical head which gyrates horizontally within an outwardly flaring curved concave bowl. Material crushed in the upper zone is said to automatically spread over a greater area as it moves downward, between crushing strokes, through the lower crushing zone to the discharge opening. Features of this new design are all-steel construction, easy and quick adjustment of discharge opening, protection against tramp iron, efficient oiling system, and quick and easy replacement of wearing parts. The eccentric is driven by an alloy steel countershaft, turning in roller bearings and equipped with a hardened steel pinion. Maximum feed is 2¼ in., and power required is from 15 to 20 hp. The capacity per hour with a ⅜-in. discharge opening is from 12 to 14 tons and a ¾-in. opening allows for a discharge of from 19 to 24 tons per hour.



A DIAMOND DRILL DESIGNED FOR STOPING AND BLAST-HOLE DRILLING

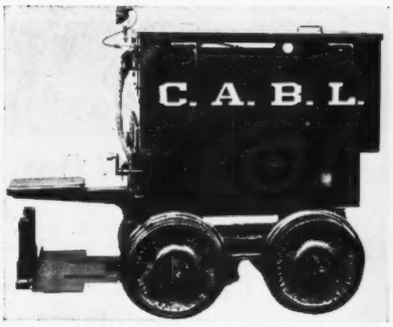
MODEL 'JV-40'—Our latest design in an air-powered diamond drill to perform stoping and blast-hole drilling. Light, rugged, powerful and dependable. Note feed-screw to blast-hole rod-coupling doing away with customary chuck. Obtainable with step-up transmission.

A complete line of Diamond Drilling equipment

PROMPT ATTENTION TO ENQUIRIES WHETHER FOR SALES OR CONTRACT

BOYLES BROS. DRILLING CO., LTD.
Diamond Drilling Contractors and Manufacturers
Vancouver, B. C.

Toronto, Ont. Kirkland Lake, Ont. Port Arthur, Ont.
Manila, P. I. Melbourne, Australia Singapore, S. S.

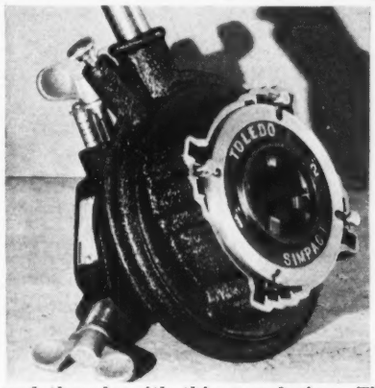


A new midget storage-battery locomotive, actual dimensions of which are determined by the storage battery and the track gage requirements, is announced by Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

Mine Safety Appliances Company, Pittsburgh, Pa., announces a new M.S.A. miner's protection suit, a durable rubber suit constructed to withstand the hard wear encountered in tunneling, mucking, drilling, and other operations where the workmen is continually subjected to unusual wet and muddy conditions.

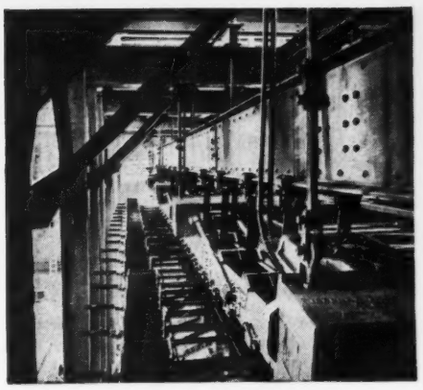
Ratchet Threader

EMPLOYING HIGH-SPEED steel dies in their new self-contained 1-in. to 2-in. ratchet threader, the Toledo Pipe Threading Machine Company, Toledo, Ohio, claims the cutting of perfect tapered threads with this new device. The dies can be quickly changed from one size to another by pushing the size selector buttons of the threading tool and



JEFFREY-TRAYLOR ELECTRIC VIBRATION

...A PRINCIPLE THAT SPELLS Lower Cost Material Handling!



AS AN EXAMPLE . . .

IT INCREASES THE EFFICIENCY OF FEEDING REVERBERATORY FURNACES

● Jeffrey-Traylor (patented) electric vibrating conveyors efficiently overcome difficulties encountered in feeding reverberatory furnaces the conventional way. Void of any mechanical wearing parts whatsoever, this J-T feeding set-up is especially suited for such hot, severe service as reverberatory furnace feeding requires. Due to electrical control, spot-feeding of ores and sinter at any point can be regulated as desired. This cost-reducing electric vibrating conveyor is just one of many J-T applications of this sound principle . . . let us send you details on how it applies to screens and feeders.

JEFFREY-TRAYLOR DIVISION
The JEFFREY MANUFACTURING Company
974-99 NORTH FOURTH STREET . . . COLUMBUS, OHIO

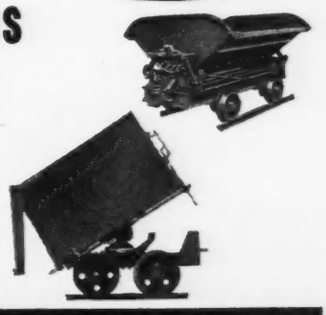
Quick, Clean Dumping Action—
High Carrying Capacity—
Rugged Durability—
High Tensile Steel Construction When Desired

KOPPEL

You get them all with
KOPPEL-BUILT QUARRY CARS

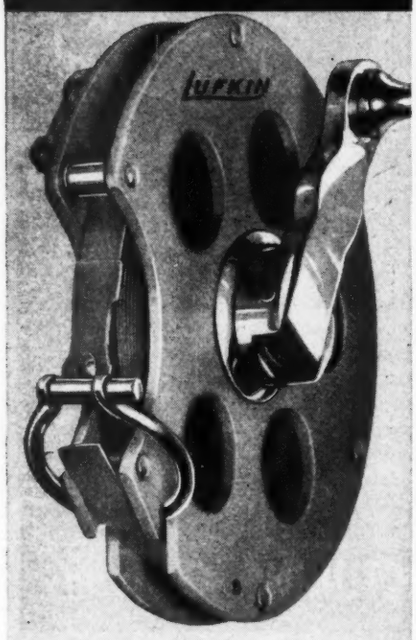
Built to the most rigid and exacting construction standards, Koppel Quarry Cars just naturally last longer and give more efficient service. With Koppel Quarry Cars, you get all the advantages of ruggedness, highest carrying capacity and quick, clean dumping action. High tensile steel construction is also available to those desiring low ratio of dead weight with maximum pay loads.

Write for your copy of our special Bulletin No. 71. Choose for yourself the car best suited to your requirements from the most complete and modern line of Industrial Cars in the world.



PRESSED STEEL CAR CO., INC. · PITTSBURGH, PA.
(KOPPEL DIVISION)

"WOLVERINE" STEEL TAPES



Civil and Mining Engineers like the "Wolverine" because it's such a practical steel tape. The engineers style line is available in various markings and is mounted on a sturdy, though light-weight, rust-proof metal reel. Perforations on one side of the reel allow easy cleaning and drying of the line. The long winding handle permits easy, rapid winding, and when turned over, locks the tape at any point. Tape removable from reel. See it at your dealers.

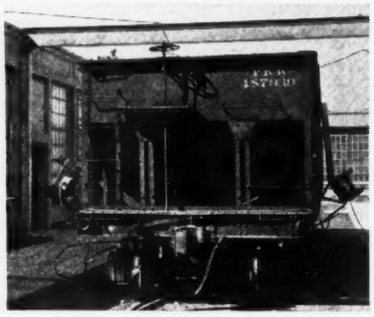
Write for Free Catalog.

LUFKIN

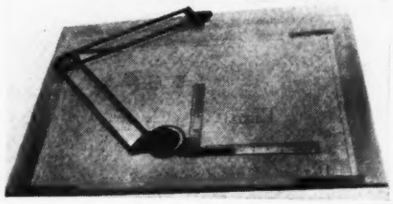
SAGINAW, MICHIGAN • New York City

TAPES · RULES · PRECISION TOOLS

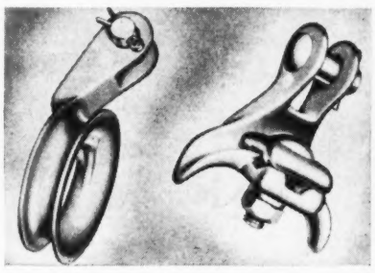
slipping the dies in the proper steps. This device is said to save approximately half the time usually required for changing sizes.



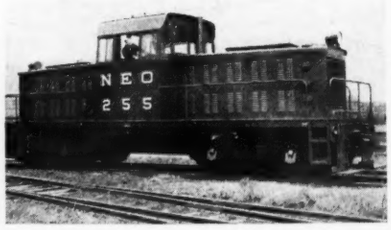
A new larger vibrator, fitted with hooks as illustrated for attaching to hopper-bottomed railroad cars to speed up the emptying process, has been developed by Syntron Company, 510 North Lexington Ave., Homer City, Pa.



Introduced as a new drafting machine, L. G. Wright, Inc., 5209-22 Euclid Ave., Cleveland, Ohio, announces its Wrigraph drafter, said to be an accurate ball-bearing instrument making drawings up to 24x36 in.



Supplementing the angle clamp and dead-end thimble designs in which the clevis is parallel to the conductor, the Ohio Brass Company, Mansfield, Ohio, introduces designs with the clevis at right angles to the conductor. This device is suitable for dead-ending, angle construction, and making branch-line taps.

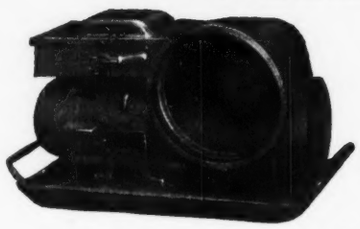


One of the 80-ton, 500-hp., diesel electric locomotives recently delivered by the General Electric Company to the Northeast Oklahoma Railroad for use in hauling zinc-lead ores and concentrates in the Tri-State area.

BLOW AWAY

Blasting Fumes and Dust With the

BROWNIE TUBING BLOWER



Step up production with adequate auxiliary ventilation and protect your men from the hazards of Silicosis.

The Model BC Blower shown is designed for use with 12" tubing, can be provided with D.C. or A.C. electric motors, and will supply 1700 to 2000 cubic feet of air per minute under average conditions.

THE BROWN-FAYRO COMPANY

JOHNSTOWN, PA.

U.S PAT # 2125332
PATS. PENDING IN OTHER COUNTRIES

HI-CASTE DIAMOND BITS

SET IN

VANKOLITE

The Perfect Bit-Metal

Low temperature setting protects diamonds used in HI-CASTE Bits—and provides the lowest diamond cost per foot. HI-CASTE Bits are available in flat-faced and double-round-nose types. Also upon request, any other standard shape, size, wall thickness, or thread. Write for descriptive literature.

J. K. SMIT & SONS, INC.

111 CHAMBERS STREET, NEW YORK CITY

Automatic Lubricator

CONTINUOUS FEEDING of lubricant to its bearing, regardless of viscosity or temperature changes, is claimed for an automatic lubricator now being sold by the Simplex Manufacturing Company, 1504 Broadway, Detroit, Mich. The lubricator is intended for replacement of grease fittings or oil cups upon vehicles and machinery of all kinds as well as for original equipment. One size, ¼ oz. capacity, is now available, but larger sizes, including types suitable for installation on steel-mill rolls, are under development.

Development of an exceptionally light and efficient respirator to protect the respiratory system against dusts, is announced by the American Optical Company, Southbridge, Mass.

SEAL-TITE KRAFT 100%

Our guarantee of Satisfaction

Largest Mining Companies Everywhere Use

SEAL-TITE TAMPING BAGS

for Safer Blasting at less cost

Seal-Tite Tamping Bags cut mining explosive costs because their seams are stronger. They are available in 65 different stock sizes for all needs. You can get the size you want from stock as needed.

Used with "THE DUMMY MAKER"

"The Dummy Maker" and 2 helpers can pack 400 to 600 bags an hour. This efficient machine pays for itself quickly—no complicated machinery—easy to use—dependable—steps up working efficiency—saves time and costly skilled labor—ruggedly built to withstand constant use—uses clay or sand for stemming material—mounted on trucks for portability—operates on ¼ h.p. motor.

Booth 503 at Metal Mining Show Colorado Springs, Sept. 16-19.

THE TAMPING BAG COMPANY
Mt. Vernon, Ill.

INDUSTRIAL NOTES

Manufacturers who contemplate placing their facilities at the disposal of the Government during the current armament program, or who make supplies and equipment needed for national defense, are advised by the Bureau of Foreign and Domestic Commerce to deal first with the field procurement and purchasing offices of the Army and Navy Departments, and to avoid direct dealing with Washington as far as possible. This procedure will conserve everyone's time and effort and will avoid needless congestion at Washington. Complete information on field procurement and purchasing offices of the Army and Navy, and a partial list of materials being purchased by these agencies, is contained in a special bulletin "National Defense Procurement, July, 1940," issued by the Bureau of Foreign and Domestic Commerce, Washington, D.C., with the collaboration of the War and Navy Departments. Reference to this bulletin will greatly facilitate dealing with the Government in the National defense program.

The National Safety Congress and Exposition will be held in Chicago Oct. 7-11. Col. John Stilwell, president of the National Safety Council, announced that headquarters will be the Stevens Hotel.

BULLETINS

General Purpose Hoist. American Hoist & Derrick Co., St. Paul, Minn. Bulletin 100 H-O describes the manufacturer's gasoline and electric powered hoists. Pp. 4.

Crosby Clips. Catalog CCB-13 illustrates the various industrial applications of the company's wire fasteners. Pp. 34.

Firebrick. A. P. Green Fire Brick Co., Mexico, Mo. Folder C-40215 describes a high heat duty firebrick. Pp. 4.

Mining Ropes. Gilmore Wire Rope Division, Jones & Laughlin Steel Corp., Muncy, Pa. Pocket booklets describe various types of wire rope for mining, excavating, and general-purpose use. Specifications and prices are included.

Steels. Republic Steel Corp., Republic Building, Cleveland, Ohio. Form adv. 353 called Double Strength Steel contains data on high-tensile, low-alloy steels, and information on corrosion, fatigue limits, fabrication, riveting, and gas and electric welding. The book is well illustrated and indexed. Pp. 40.

Placer Dredges. Bucyrus-Erie Co., South Milwaukee, Wis. Bulletin PD4 describes and illustrates the manufacturer's line of dredges for placer mining and other purposes. Data are comprehensive and the bulletin is handsomely illustrated and has two pages devoted to useful operating information. Pp. 35. **Cranes.** Bulletin LCC-1 describes and illustrates the manufacturer's complete line of crawler cranes. Pp. 35.

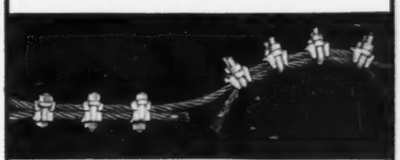
Reflector Button. Portable lamp & Equipment Co., 73 First Ave., Pittsburgh, Pa. Bulletin No. 2 describes the manufacturer's switch signal device of the reflector button type. Pp. 1.

Ball Bearings. New Departure, Bristol, Conn. New Departure Handbook Vol. 1, 13th edition is a 6x8-in. spiral binder book describing and illustrating the manufacturer's types of ball bearings and bearing mountings, and data on bearing selection are included. Pp. 150.

Mechanical Loaders. Eimco Corp., Salt Lake City, Utah, has just published illustrated Bulletin No. 105 on the use of Eimco-Finlay loaders, Models 12-B and 21. In addition to describing the mechanical construction and operation of the loaders, the book is generously illustrated with underground views showing loaders in action. One section of the bulletin is devoted to diagrammatic illustrations of the application of loaders in various methods of mining. The bulletin will be sent free to mine engineers or executives who may have use for mechanical loaders.

THERE'S NO CRIMPING WITH THIS CLIP— IT GRIPS LIKE A FIST!

The Laughlin drop forged Safety Clip grabs wire rope with a grip like a fist—a vise-like, solid clench that *stays put*. When removed, it leaves the wire rope straight, uncrimped, ready to use again.



FOOLPROOF. Laughlin Safety Clips are easier and safer to apply. They can't be put on wrong. No fussing or waste of time. And three Laughlin Safety Clips will do the job of four ordinary U-Bolt Clips.

DOUBLED EFFICIENCY. Tests recently made by a leading engineering school prove Laughlin Safety Clips 50% more efficient than ordinary U-Bolt Clips.

FREE BULLETIN TELLS MONEY-SAVING FEATURES OF LAUGHLIN SAFETY CLIPS

These tests are described in a new booklet — which also gives other advantages to be gained by using Laughlin Safety Clips. Fill out the coupon below — and mail today. No obligation.

THE THOMAS LAUGHLIN CO.
Portland, Maine

Please send me free Safety Clip booklet E-7.

Name .....

Company .....

Address .....

Check here for catalog on items below ☐

Look for Laughlin products in Metal & Non-Metallic Mining Catalog and buy through your distributor.

Camera Highlights of Performance

SIX FOOT DIESEL ELECTRIC DREDGE

COLOMBIA, SOUTH AMERICA

Installed—1937; latest report: Month of May, 1940—88.4% digging time . . . 178,848 cubic yards. Note character of digging.

STACKER SCOW

MONTANA, UNITED STATES

BUILT 1933

Excerpt from unsolicited letter: "This plant has been in operation two months short of six years and has given us very satisfactory service."

EMPIRE DRILL

Above projects proven by Empire Drill. The most accurate and economical tool for exploration of placer deposits.

NEW YORK ENGINEERING COMPANY

75 WEST STREET *Works:* **YONKERS, N. Y.** **NEW YORK, N. Y.**